Water spectrum

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Water spectrum

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COVER: Annual growth rate of 2-3 centimeters on this sunken ship, which went down in 1944, indicates nature's relative speed in artificial reef building.
See page 27.

The Four Futures of Omaha:

An Introduction

by Fred Thomas

An unexpected source is causing eastern Nebraskans and western Iowans to take a new look at their communities and their uses of natural resources. That unexpected source is none other than the U.S. Army Corps of Engineers. Who would have thought the Corps would be offering alternatives for city growth, outlines for land use, unusual ways to dispose of sewage, plans for solving a shortage of public recreational areas, details of community water problems, and similar concepts for a region's future.

In this Midlands region, the Corps has been the agency that, over the years, our communities have turned to for flood protection and related problems. So the unveiling of the Corps' "Water and Related Land Management Study for Metropolitan Omaha-Council Bluffs" brought a new dimension to Corps involvement in this area of more than a half-million residents.

Until the Study came out, the Corps was most in the public eye over its plans for preventing floods in the Papillion Creek valley which laces populated residential and business areas of Omaha.

Thus, it seemed novel to have the Corps outlining four alternative concepts for growth of the metropolitan area. Prior to the Corps study, few—except environmentalists—had voiced concern over Omaha's continually moving westward, creating the myriad of difficulties associated with urban sprawl.

But here, in booklet form, came projections on costs, population, transportation, energy use, and other topics as they relate to four concepts: unfettered urban sprawl, constrained city growth, constrained growth coupled with development of satellite cities, and sprawl channeled along major roadways.

These concepts were more detailed and far-reaching than any that city and State officials had ever presented to the public, and they started many persons questioning whether metropolitan Omaha's hodge podge, unrestricted growth should continue.

Mr. Thomas is environmental editor of the Omaha World-Herald. He has covered the progress of the Omaha Urban Study and has written numerous articles on this subject.

Public meetings and other sessions prompted citizen and environmental groups and others to pass resolutions on growth plans. Some criticized the Corps for just laying out the four concepts and not recommending one over the others. Despite the absence of recommendations, the growth study has renewed interest in rekindling Omaha's and Council Bluffs' inner cores and restraining suburban growth.

Then came the study's second booklet—a look at water quality. The topic was more familiar than growth, since Federal officials have been working with our metropolitan communities for more than 10 years to reduce contamination of the Missouri River with everything from packing plant wastes to industrial chemicals.

Here again the Corps offered new insights and alternatives, such as funneling treated wastes onto nearby farmlands as a fertilizer and soil conditioner instead of pouring them into the Missouri, the principal drinking supply for many communities.

The study also offered new alternatives for handling the 5-billion gallons of contaminated water which pour into the Missouri yearly whenever city sewers that carry both storm runoff and sewage overflow directly into the river.

The alternatives were an imaginative plan to develop underground holding basins that have tennis courts, parking or other public facilities built atop them; construction of dikes in the river to hold overflows; a tunnel to channel storm sewer overflows to a reservoir; and storage of the water in a mine.

Just as many persons were pondering the relation between the growth concepts and water quality needs, Volume Number 3 on water supply emerged. To me, it awoke some citizens to the need for new planning and action to insure an abundant, high quality drinking water supply. Nebraskans for years have prided themselves on having the Nation's most abundant supply of underground water; but that pride has shielded some from the fact that the supply isn't inexhaustible and drinking water quality is not always the best.

In recent years, the appearance of nitrate traces in some wells out-state and the drying up of other wells caused ripples of concern in some quarters. But it wasn't until the Corps' comment on water supply and quality that many metropolitan area residents realized their water might not be all they thought it was. The Corps assessed quality of water in more than 55 communities, and a listing of shortcomings in the World-Herald brought many comments on what citizens might do. Some communities now are moving to provide better water.

The study's next volume outlined the metropolitan area's serious shortage of outdoor recreation areas. Outdoor buffs and conservationists for years have tried to get more public areas developed, but their pleas never pinpointed the problem and possible solutions as precisely as the Corps. Thirty-four percent of the State's population lives in an area containing only 1.5 percent of Nebraska's recreation lands.

The Corps outlined more than 75 specific sites which could become public land and water recreation areas, including many along the Missouri, Platte and Elkhorn Rivers which, unfortunately for sportsmen, have shorelines almost exclusively in private ownership close to Omaha-Council Bluffs.

As with other suggested improvements in the Corps study, public officials say they lack money to acquire more public recreation areas. At this writing, a Corps suggestion to turn a bankrupt lakeside housing development into a public use area is under consideration.

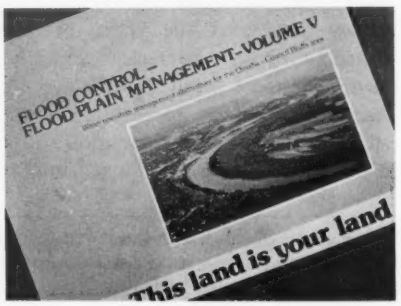
Flood control and flood plain management have been hot topics in metropolitan Omaha since the mid-1960s when floodwaters 2 years in a row brought death and damage to the Papillion Creek watershed.

Corps proposals have been caught in a crossfire between those rural residents who do not want to yield their lands for construction of dams and those city residents and developers who seek flood protection, especially those who are living or working in a known flood plain. The Corps has altered its plans, opponents have gone to court, a restudy is underway, and final decisions on reducing flood damage are to be made in 1976.[1]

Although the controversy is far from settled, it has had a positive effect in creating a new understanding among many citizens about the hazards of allowing uncontrolled development in flood plains. Many now urge the alternative that would restrict flood plains to public recreation and wildlife use.

It will be years before one can assess the impact of the Corps study. As with other studies, whether Corps recommendations gather dust on a shelf or become realities remains to be seen. Nevertheless, to this observer, the information booklets spread among the people, the public meetings, the controversy, the critiques and the resultant coffee shop conversations stimulated have greatly increased citizen understanding of an essential segment of metropolitan Omaha life. □

[1]At the time this article went to press, no final decision on the flood control project had been made.



A citizen information booklet.

The Four Futures of Omaha

by Donald Kisicki

The Urban Studies Program is one of the lesser known missions of the U.S. Army Corps of Engineers. In this time of public concern about energy shortages, sprawl and urban blight, our environment, and the need to preserve prime agricultural land, the program's goal is to help regions solve their water and related land resource problems. It assists metropolitan areas by providing them with a range of urban water resource plans compatible with their development goals. Of the 32 urban studies thus far participated in by the Corps, the Omaha, Nebraska-Council Bluffs, Iowa study is the first to be completed.

The Corps' role in the urban study is to organize ideas about growth and managing water and related land resources, to evaluate impacts, and to present this information to area residents so they can make intelligent decisions about resource utilization. This role is useful for achieving citizen participation and enables the completed study to reflect regional goals and objectives regarding land use.

The Urban Studies Program is intended to provide an integrated approach to management of local water and related land resources over the next 50 years. The Omaha Urban Study, therefore, was a cooperative planning effort of the Corps of Engineers and several other agencies, particularly the Metropolitan Area Planning Agency.

Many Americans are awakening to the sobering reality that limited natural resources are supporting unlimited growth. Among the already enlightened are the citizens of metropolitan Omaha, Nebraska-Council Bluffs, Iowa, adjoining communities divided only by a river and a State line. It was these citizens, supported by the Corps of Engineers and other Federal agencies, who initiated this particular study.

Recognizing the problems being created by haphazard urban sprawl, the Corps of Engineers, along with other agencies and the area residents, themselves, responded with a set of four possible growth patterns, or futures, encompassing the entire metropolitan region. These growth patterns were descriptively named by a local college which early in the planning process analyzed various land use trends in the study area.

Super Industrial State, concept A, continues the present trend of urban sprawl in which suburban

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Mr. Kisicki was study manager of the Omaha Urban Study. He is currently a planner in the Office of the Chief of Engineers in Washington, D.C.

growth is encouraged by economic and political forces. It depends on high land and energy consumption. The American dream of owning a house on enough land to ensure some privacy is probably best realized with this future.

Green Revolution, concept B, emphasizes controlled growth of the urban center and small cities separated by open countryside from the urban center and each other. It is based on a densely populated urban core surrounded by substantial development in adjacent rural communities. Each city would be self-sufficient with enough economic activity to provide jobs. A reduction in transportation costs is possible with this future.

Restoration Society, concept C, is characterized by redevelopment of the older areas coupled with higher density growth in the suburbs. New and redeveloped areas were projected at double the density of the Super Industrial State. Energy conservation is most feasible with this concept.

The fourth future, concept D, is similar to the Super Industrial State except that it assumes substantial development will occur fingerlike along the major transportation arteries. This pattern makes possible the development of a mass transit system to accommodate the population concentrations located along the corridors.

The four futures offer choices for solving such problems as inner-city decay, traffic congestion, eroding tax base and loss of open space. They formed the basis of our studies on water quality, water supply, flood control and recreation.

The Beginning

In 1970 a local group of persons with downtown interests formed the Riverfront Development Committee. They wanted to revitalize the Omaha riverfront along the Missouri, both economically and environmentally. By 1971 their idea had developed into the Riverfront Development Program and covered an area along the Missouri River approximately 30 miles south and 30 miles north of downtown Omaha and Council Bluffs.

To be eligible to receive Federal funding, the Riverfront Development Committee in 1972 merged with the Metropolitan Area Planning Agency (MAPA), a regional council of governments comprised of elected officials from the six Nebraska and Iowa counties surrounding the metro core. MAPA was already qualified to receive Federal funds and could serve as a clearinghouse in passing on the monies to the committee. From that time the committee was known as the Riverfront Development Department of MAPA.

1970 also saw the beginning of the Corps' new assignment. In that year Congress authorized the Corps to conduct a series of pilot wastewater management studies for several metropolitan areas. The Federal

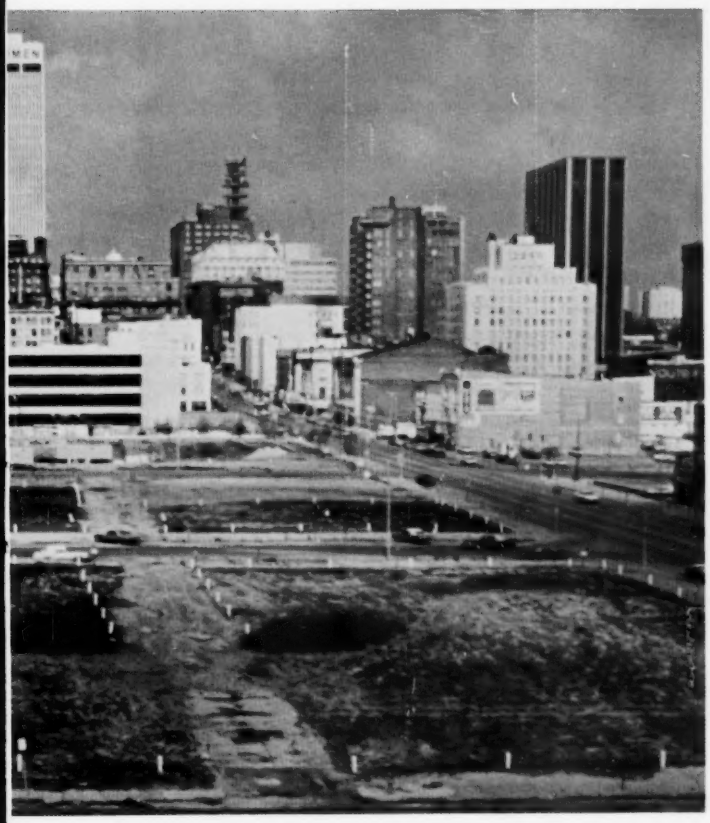
Seven-county metropolitan Omaha study area encompasses 36,000 square miles and has a current population of more than 600,000.

Water Pollution Control Act Amendments of 1972 continued Corps involvement by authorizing the agency to provide areawide wastewater management planning assistance to States and local governments.

Having developed a concept for revitalizing the riverfront, the committee sought the assistance of several Federal agencies. Because one of the Corps regional headquarters was already located at Omaha, the committee believed the Corps would be the logical Federal agency to coordinate and provide direct supervision of all applicable Federal programs. The local committee, working through its Congressmen, asked for Corps assistance.

The resulting congressional resolutions, more limited in scope than desired by the local committee, requested wastewater management studies similar to the pilot wastewater management studies already authorized by Congress. The resolutions also requested studies in the areas of water supply, flood control and water related recreation.

Dynamic revitalization process extends several blocks inward from the Missouri River.



Initial funding was made available in January 1972 and the preliminary Omaha Plan of Study was approved a year later by the Office of the Chief of Engineers. The study area encompassed seven counties along the Missouri River boundary between Nebraska and Iowa. During this period the Urban Studies Program was being developed by the Corps as a logical extension of the pilot wastewater studies program.

From the beginning the Corps recognized that participation of the area residents was essential to a successful study. Early in our planning a public involvement program was created to establish two-way communication with the citizenry at large as well as local, State and regional officials and influential persons. We kept them informed through special coordinating committees, presentations and pamphlets and actively sought the opinions of citizens during each phase of the planning. An interagency committee was formed from local, State and Federal agencies to periodically review and guide the planning efforts. Close coordination was maintained in individual meetings with local and State agencies on specific study topics.

In later stages of the study, Mr. Fred Thomas (see preceding article) reported on each of the pamphlets in mass media news articles which resulted in greatly increased citizen participation.

The total public involvement program consisted of 17 public meetings, more than 100 coordination meetings and 40 presentations to organized groups, and the distribution of 11 different documents totaling more than 22,000 informational units.

Planning For The Futures

The water resource plans developed within an urban study must be compatible with the urban development goals of the region. But in the Omaha-Council Bluffs area, no consensus on future development goals could be obtained from the public; in fact, considerable controversy existed.

Local residents and planners did want a more sensible form of urban growth than currently exists in the Omaha-Council Bluffs region. While there is great concern over low density urban sprawl, that pattern prevails, fostered by land speculation and the ease with which developers can form independent sanitary and improvement districts. In a period of increasing public involvement, the informed citizenry has become aware that water and sewer systems, flood control measures and transportation systems are not single purpose measures but are tied directly to the implementation of growth policies.

A central question of the Omaha study was how to approach the locally suggested land use concepts. Selecting one future development pattern actually would place the Corps in a land use advocacy position in the midst of land use controversy. The message that emerged

from early public involvement was: "Orient your study to reflect land use concerns if you want to be relevant to the issues of the region." Our approach to land use was to develop plans, costs and impacts for water resource systems to complement the alternative growth futures.

Plans, intended to solve problems such as flood control, were developed for each study element and then narrowed to a relatively few alternatives. These alternatives were then combined into four comprehensive resource management plans which matched the four alternative land use concepts. The four futures are not plans; they are concepts of what could occur with a given set of circumstances. This lengthy planning process enables the public to make a choice concerning growth policy and resource utilization by selecting a water resource plan to support a desired growth policy.

An important citizen consideration in choosing among alternative futures is the large cost impact of political decisions about land use.

Section 208

The Federal Water Pollution Control Act Amendments of 1972 were enacted about the same time the preliminary Omaha Plan of Study was completed. The amendments made it necessary for the Corps to expand the recently completed MAPA Comprehensive Water Pollution Control Plan. Finding the most efficient methods for fulfilling the act's new planning requirements and meeting its goals was a major component of the Omaha Urban Study.

Three goals set by the new legislation were secondary treatment of all municipal wastes by 1977; fishable, swimmable waters by July 1, 1983; and zero discharge of pollutants into national waters by 1985.

Section 208 contains considerations for land use and water quality relationships that must be addressed in wastewater plans.

In the Omaha study these relationships were addressed by formulating plans which recognize that sewers, like highways, can be a major factor in detracting from or supporting a growth policy. Sewer plans envisioning different degrees of interceptor expansion and regionalization were formulated in accordance with both the four futures and protection of water quality. The higher density concepts of futures B and C, for instance, require less extensive sewer systems than the sprawl concepts of futures A and D.

Alternative waste management techniques had to be evaluated to identify the most effective method for meeting the 1977, 1983 and 1985 requirements and goals of the amendments. In addition to treatment plant technology, the Omaha study investigated the feasibility of irrigating agricultural land with wastewater. While land application did not prove to be an economical alternative to secondary treatment, it did prove to be the most cost-effective method for achieving the 1985 zero discharge goal.

The Omaha study also developed alternatives to abate sewer and urban runoff pollution. These combined sewer alternatives demonstrated that the traditional method of sewer separation is not the most cost-effective solution. This finding will potentially save the citizens millions of dollars.

Supplying Water Until 2020

Parallel to the wastewater studies, a regional water supply study was conducted. To address water supply-land use relationships, four alternative distribution plans were developed to match the four futures. Our assumption was that water system planning, like sewer system planning, must be totally integrated with land use planning so that water systems become a tool to direct rather than follow urban growth.

An analysis of the four distribution plans indicates a present worth cost savings of about $40 million in capital costs over the next 50 years if, for example, future C is followed instead of future A. The controlled growth pattern in future C results in a less extensive expansion of the distribution network. A 6.6 percent reduction in average day use and a 14.0 percent reduction in peak hour demand were determined to be possible from an analysis of the respective water requirements of the sprawl versus compact growth patterns.

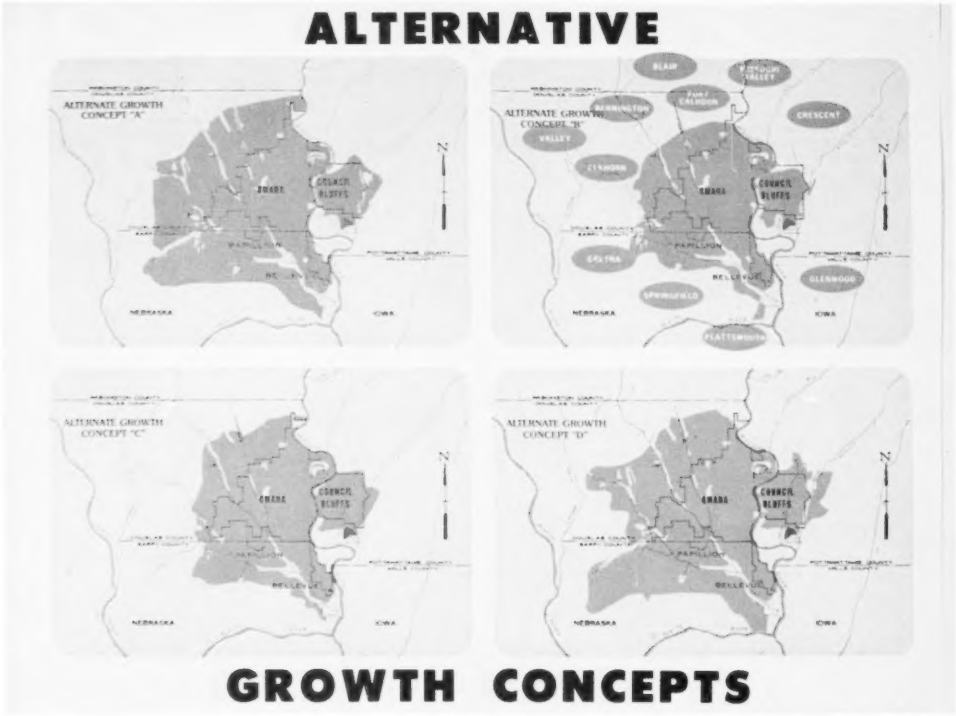
For the urban area, several innovative approaches to water supply management were investigated. They included methods for reducing water use, dual water systems, and the use of nontraditional supply sources such as urban storm runoff and wastewater recycling.

Citing the American philosophy of "the more the better," major water utilities in the study area indicate that the increasing per capita water use rate alone will require an additional 40 million gallons a day by 2020. Based on the public's desire for conservation of all resources, the study investigated 11 methods for reducing water use, ranging from voluntary actions to unitized residential recycling.

The most practical method for all futures appears to be the use of water conserving types of fixtures and appliances such as shower heads, washing machines and toilets. A widespread conversion to their use could achieve as much as a 31 percent reduction in future residential water requirements. If used in all residential construction, such appliances could save about $1.3 million a year by 2020 in treatment costs and more than $10 million in facility construction costs over the next 50 years.

While the entire water supply of the metropolitan area is treated to the drinking quality standard, only 4 percent is used for drinking. Dual water systems were investigated as a means to achieve cost effectiveness by providing a closer match of quality supplied to quality required. The feasibility of using urban storm water runoff and wastewater recycle as alternative sources of water supply was investigated in conjunction with dual

Plowed fields continue to shrink from advancing suburban development. Part of this area, once agricultural, is now a flood control reservoir with recreational facilities of benefit to nearby urban population.



Four futures or growth concepts, each with a different cost impact, embody competing land use goals.

water systems. However, the relative abundance of water resources in the region and high piping costs proved to far outweigh any advantages gained.

For the adjacent rural areas, the adequacy and quality of the smaller municipal water systems were evaluated. Only three systems out of a total of 53 were found to meet the desirable quality standards established by the U.S. Public Health Service and the system reliability of the Safe Drinking Water Act of 1974. Analysis showed that plans featuring supply and treatment centralization at the county level were more cost effective and reliable than the existing county plans which covered 31 rural water systems.

Managing Flood Plains

The Omaha study identified 10 separate areas that are vulnerable to flooding. The Platte-Elkhorn flood plains area faces the greatest potential flood damage threat in extent of area covered. The largely urbanized Papillion Creek flood plains suffer the greatest damage in terms of economic costs because Papillion Creek flows through the heart of Omaha. Both nonstructural and structural methods were evaluated. In nine of the areas, flood plain zoning and flood insurance[1] were concluded to be the only feasible alternatives.

In the tenth area the authorized plan for the Papillion Creek Lakes Project was reevaluated as part of our study. The flood plain management analysis was required because of rising investment costs of urbanization and the effects of the Flood Disaster Protection Act of 1973 which regulated flood plain development. Possible solutions to flood problems in 10 areas were investigated. This authorized project consisted of 20 dams and reservoirs on tributaries of Papillion Creek.

For the reevaluation, the Papillion Creek basin was divided into its three natural drainages: the Big Papillion, Little Papillion and West Branch.

The authorized plan for the Big Papillion drainage called for 10 multiple purpose dams and reservoirs. One dam is already completed. After analysis, a single dam was recommended by the Omaha District Engineer to replace the other nine dams. The single dam was considered when a railroad line, which would have had to be moved to build the dam, was abandoned. This recommendation should save $15 million, 3,000 acres of land and would require the relocation of 18 fewer families.

The reevaluation determined that the only dam not yet constructed in the Little Papillon drainage is still justified.

[1]See "A Turning Point" by George K. Bernstein, Volume 6, No. 2, 1974.

ESTIMATED COSTS OF ALTERNATIVE GROWTH CONCEPTS BY 2020

	Concept A		Concept B		Concept C		Concept D	
			Land					
Land Required (Acres)	49,000	72,000	22,000	30,000	29,000	43,000	45,000	71,000
			Public Costs[1] (All Costs in Millions)					
Utility Costs								
Water Lines[2]	113.4	175.0	97.5	142.0	90.0	136.0	117.6	176.0
Sewer Lines[2]	56.0	91.0	45.0	64.0	41.0	62.0	54.0	83.0
Storm Drainage	84.8	135.5	67.5	99.8	62.0	98.8	89.9	134.7
Gas Lines[3]	8.7	13.8	7.0	10.5	6.5	10.4	8.3	13.8
Electricity[3]	25.0	33.7	19.0	31.7	17.0	30.3	21.7	34.3
Telephone	14.9	23.7	9.7	20.0	12.9	20.0	14.4	23.6
Streets and Roads[4]	205.8	328.6	175.3	266.8	165.0	264.4	199.7	327.6
Residential Construction	2,200.0	3,507.0	1,884.0	2,855.0	1,791.0	2,840.0	2,126.0	3,491.0

1. Capital costs to service population at 2020 estimates.
2. Does not include water and sewage treatment costs which are relatively equal for the four concepts.
3. Distribution costs only.
4. Does not include major arterials such as expressways, interstates, etc.

Because of rapid urbanization of the West Branch flood plain, projected to continue according to uncontrolled growth patterns A and D, eight dams had been authorized in this drainage basin. The Flood Disaster Protection Act significantly affected the economic justification of the West Branch project which had been based on projected development, now curtailed by this act. As a result, a full scale reformulation is underway with a substantial reduction in the number of control reservoirs anticipated.

The proposed changes to the Papillion Creek Lakes Project were incorporated into the study. Because of the traditional conflict of interests between upstream and downstream residents, the reevaluation became the most controversial element of the Omaha Urban Study.

Enjoying Our Natural Resources

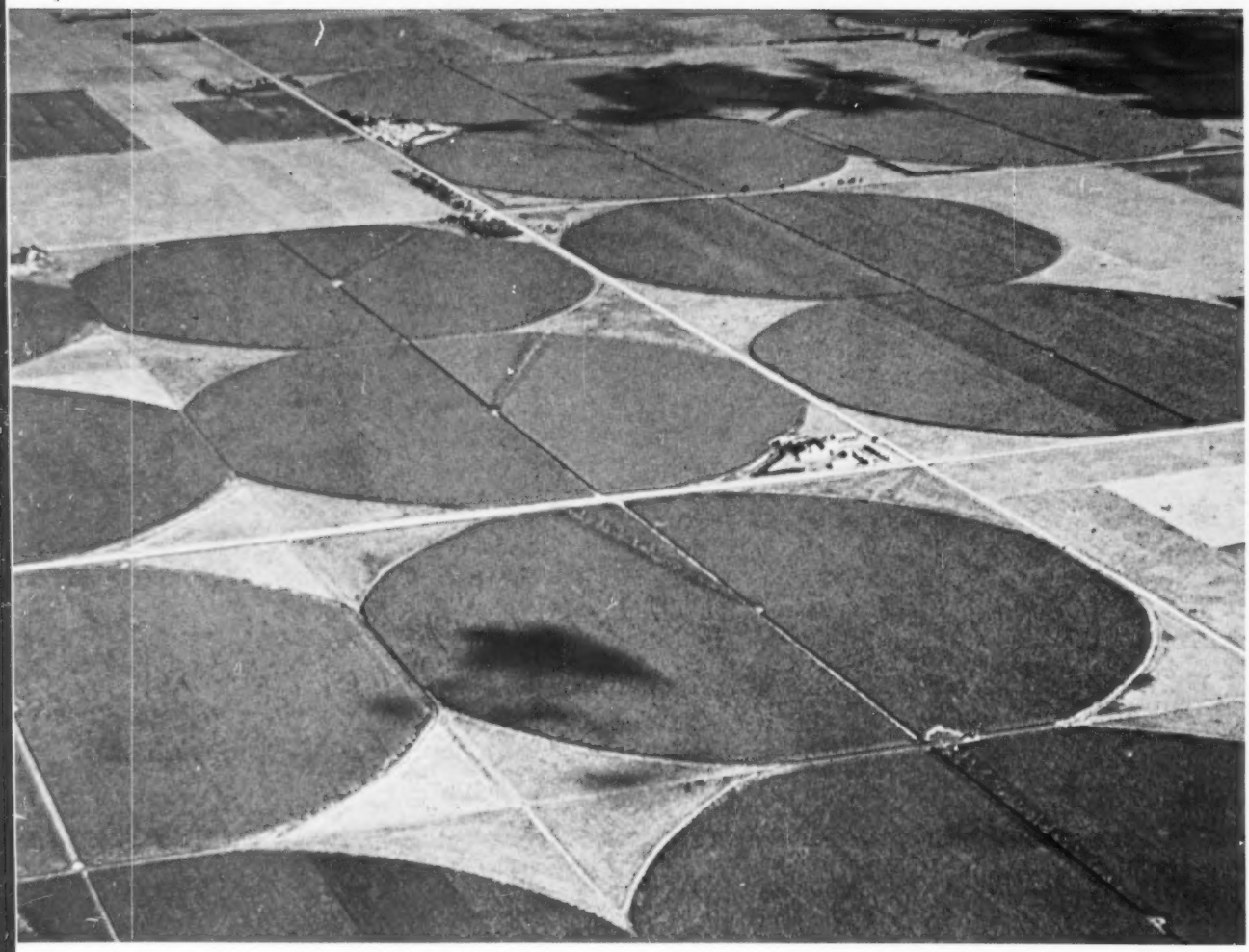
Although leisure time activities are growing increasingly important in the United States, earlier State level studies found that the Omaha area lacks adequate recreational opportunities. The region contains 34 percent of Nebraska's population but less than 2 percent of its recreation lands.

Large recreation land deficiencies exist in lake related recreation, public access to rivers (most of the riverfront property near the urban centers is privately owned) and preservation of unique ecological areas against urban encroachment.

Limiting urban growth will help preserve open space on the urban fringe. Encouraging growth in smaller communities, as in the Green Revolution concept, will bring residents closer to open space and recreational opportunities.

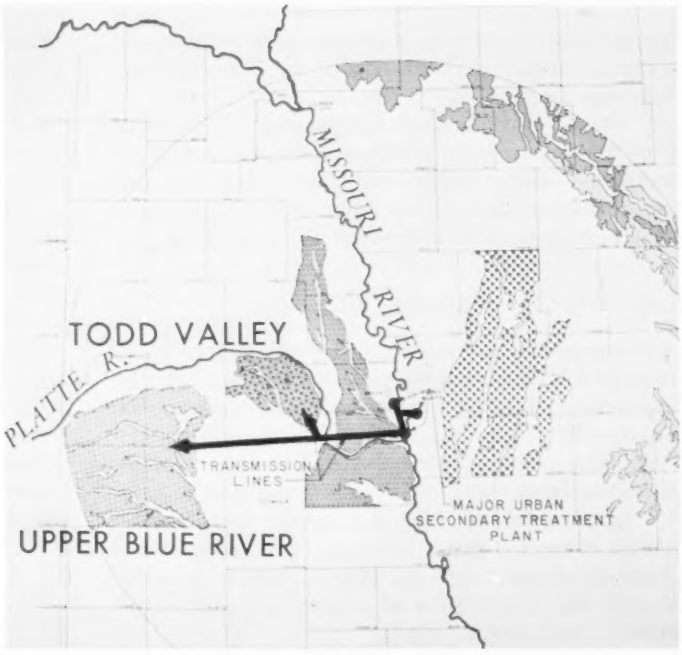
The Bureau of Outdoor Recreation and the Corps worked together on this component of the study, primarily by combining existing recreation plans formulated by MAPA and other agencies. Two major resource areas were identified totaling 49,000 acres on the flood plains of the Platte and Elkhorn Rivers and the Missouri River. A third area of identified opportunities lies within the Papillion Creek basin.

The authorized plan there would have provided more than 17,000 acres of recreation areas located in a semicircular green belt around metropolitan Omaha. Even with the substantial modifications resulting from the reevaluation of the flood control project, it appears that the minimum amount will include more than 5,000 acres of recreation lands and 2,000 water surface acres. The land along both sides of Papillion Creek, which runs through the center of Omaha, is extremely flat, making it vulnerable to flooding but also suitable for use as a linear parkway. Some 12,000 acres of flood plain lands were identified for this purpose.



Above– Center pivot irrigation systems, already a familiar sight in Nebraska, are fostering public acceptance of treating wastewater through land application.

Both the Todd Valley and Upper Blue River areas offer excellent potential for wastewater irrigation.



The Next Step

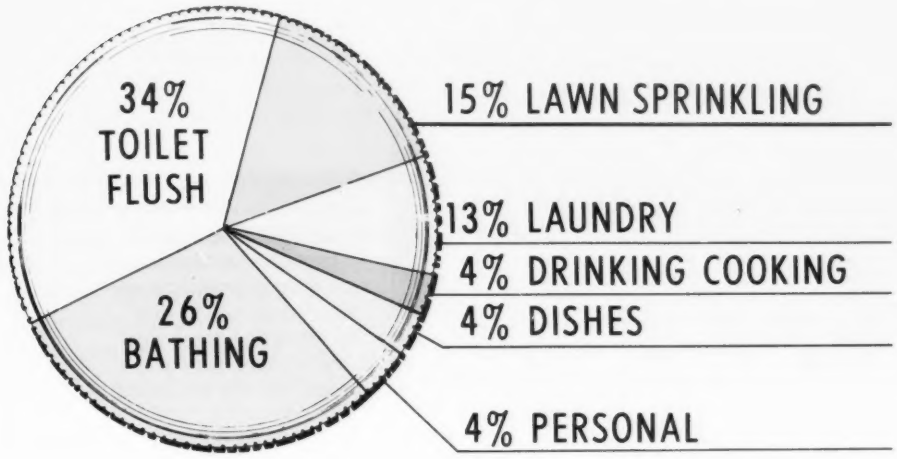
The final product of the study consists of a number of alternative courses of action leading to the selection of a resource management plan. Activities at the State and local levels are currently aimed at selecting alternatives.

The real output of the study is a group of analyses upon which future compromises and decisions can be made by local residents. The information and data developed in the course of this investigation will be used by many planning agencies. MAPA, for example, is using the public cost implications and public reaction to the alternative growth concepts, shown in the accompanying table, in its development of a new comprehensive plan for the metropolitan area.

The States or MAPA will be assisted by our wastewater management analyses and plans, with slight modifications, in their task of formulating and adopting a Section 208 areawide wastewater management plan which will serve as the basis for obtaining construction grants from the Environmental Protection Agency.

Local governments will utilize the flood plain studies in making flood plain land use decisions. In the Papillion Creek basin, the studies already have led to more cost-effective plans than the authorized project while reducing adverse social effects. Although financial obstacles do exist, the comprehensive recreation study provides local governments with targets toward which they can direct their efforts. The water supply plan developed will guide local agencies in the location and construction of new supplies and transmission lines.

The Omaha Urban Study has been a step in the continuing planning process required for wise utilization of area resources. We have collected, developed and analyzed information; coordinated with other agencies and their plans; and organized the information and presented it to the public. The study can be considered a success because it has developed concepts and alternatives that have changed public investment attitudes. These changed attitudes potentially can save taxpayers millions of dollars in the coming years. The people of metropolitan Omaha-Council Bluffs now have a sound data base upon which to make intelligent decisions about their future.□



The study investigated the uses of water and methods for conserving it.

Biologists Bug Southern Water Weeds

By David Vogel

Beauty of the exotic water hyacinth in bloom and its prolific reproduction rate have proved a devastating combination that still threatens the navigability of many waterways throughout the Southeast.

No one realized it at the time, but the introduction of water hyacinths into the southeastern United States in 1884 was to have costly consequences lasting well into the waning years of the 20th century. The debut of the exotic plant from the rain forests of South America was auspicious enough; it was a favored guest at the New Orleans Cotton Exposition and was passed out to eager visitors who coveted the lovely light blue and purplish tinged blossoms and heart-shaped leaves for their own garden pools and backyard ponds. But the seemingly harmless hyacinth soon wore out its welcome and overwhelmed its naive admirers more with its speed of reproduction than its beauty.

Prolific as it was pretty, the water hyacinth quickly overgrew the cramped backyard ponds of Louisiana and Florida—where it flourished profusely because of warm temperatures and heavy rainfall—and when the excess plants were tossed into nearby rivers and lakes by harried gardeners, they continued to proliferate.

It didn't take long for Louisianans and Floridians to realize, and write their Congressmen, that the water hyacinth was a weed in chic clothing. The weed doubles its number every 10 days, with each plant sending out runners that sprout new plants and also produce seeds. Ten water hyacinths can cover an acre with 200,000 plants in just 8 months. By 1894, only 4 years after the hyacinths had been thrown out of a private aquarium and into the St. John's River in Florida, they clogged the river bends so thickly as to render parts of the river unnavigable. Steamboats were slowed and sometimes

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Mr. Vogel was a summer intern at WATER SPECTRUM. He has since returned to the University of North Carolina at Chapel Hill to pursue a master's degree in journalism.

Controlling the water hyacinth merely allows alligatorweed to encroach on areas formerly infested by hyacinths, such as on North Edisto River near Charleston,S.C.

even locked in by the mats of thickly packed plants and their short, tangled roots.

Today, 80 years after its recognition as a pest, the water hyacinth is still costing Florida $3 million a year to control. It ranks as the single most troublesome aquatic weed in the world and as one of the world's top 10 weeds. Besides clogging inland waterways, it provides a fertile breeding ground for mosquitos, prevents a free exchange of oxygen between the water surface and the air—suffocating fish and other marine animals—and increases water loss in irrigation canals via evapotranspiration,[1] thereby increasing farm production costs. Armadas of water hyacinth mats, torn free by storms and floods, float downstream and threaten the stability of bridges with their accumulated weight heaped up against the pilings.

The Army Corps of Engineers became involved in aquatic weed control as a direct result of the rampaging water hyacinth. Congress first authorized the Corps to remove this obstacle to navigation in the River and Harbor Act of 1899. Thus began a long battle between the Corps and the water hyacinth that, until recently, was characterized by expensive, innovative failures on the part of the Corps and tenacious fecundity by the plants.

At first the Corps was fairly successful using sodium arsenite as a herbicide. Unfortunately, the chemical also poisoned the cattle which browsed on the sprayed plants and, as a result, the River and Harbor Act of 1903 outlawed spraying with chemicals harmful to cattle, which ruled out all herbicides existing at the time.

From that year until 1945 the Corps relied heavily on machines, mostly large contraptions that chewed up, crushed or otherwise removed the water hyacinth from clogged waterways. One type was the crusher boat which squeezed the life out of the water hyacinth mats by peeling them off the water surface in large strips onto a conveyor system, thrust over the bow, that fed them between heavy rollers. Then came the destroyer boats, with a row of circular saw blades turning on a 40-foot-wide axle attached to the bow, that cut a swath through the mats by shredding the hyacinths into small scattered bits.

These were only stopgap measures. The few untouched plants, together with the 45 million seeds left behind in every cleared acre, quickly reestablished the water hyacinths in their original density, and it became obvious that mechanical control methods would require frequent repetition. A year or two after the mats had been obliterated, the crusher or the destroyer boat would have to return.

[1]The process which pulls water through plants by the suction created from evaporation off the leaves.

Early attempts at aquatic weed control relied on machines such as this old destroyer, with its circular saw, and modern harvester to mechanically remove the thick vegetative mats.

The next phase of the aquatic weed control program began with the recognition of the weed killing properties of a newly synthesized organic compound called 2,4-dichlorophenoxyacetic acid (2,4-D). This herbicide quickly replaced the ponderous machines, changing the nature of the program from a mechanical to a chemical treatment process. Treatment by 2,4-D could be accomplished by spraying it over the plants from boats and airplanes. Not only did 2,4-D kill off water hyacinths better than any mechanical method, but unlike earlier herbicides, it was also nontoxic to cattle and relatively cheap. Although 2,4-D met with general success—killing water hyacinth faster and cheaper than anything else—the Corps still ran into several problems with its use.

One problem was inflation. As late as 1970, the Texas Parks and Wildlife Department reported a cost of only $4.75 an acre for its application on Lake Corpus Christi; 5 years later the price had escalated to $8.00 a gallon, which translated into $12 to $50 an acre—depending on whether the herbicide was sprayed from airplanes or applied by less efficient means.

Another familiar problem was that, like mechanical controls, 2,4-D treatments had to be reapplied periodically. Added to the increased cost of each reapplication was the danger that, while spraying water hyacinths, some of the 2,4-D would be carried by the wind onto nearby crops and kill important food plants. The Corps tried to combat this tendency by reducing the drift through an increase in the size of the sprayed droplets, but still wound up paying out cash settlements for damage done to tomato and cotton crops.

Despite these drawbacks, 2,4-D was the first moderately successful, comparatively safe herbicide, and it was significantly more efficient and economical than the mechanical controls. To this day, 2,4-D is still the best form of control, but its success spawned the seeds of its own obsolescence.

The success of 2,4-D permitted the invasion of the previously suppressed, herbicide resistant alligatorweed into areas cleared of water hyacinth. Alligatorweed was brought into the United States from the same central South American region containing the water hyacinth, at about the same time in the late 19th century, but did not reproduce and spread as quickly as the hyacinth. Dr. Edward O. Gangstad, a botanist in the Office of the Chief of Engineers, explained that mats of both plants can grow next to each other, even touching at their perimeters, but with little intermingling. Since the water hyacinth spread faster, it colonized and held onto more aquatic territory than the alligatorweed.

The 2,4-D treatments were to the alligatorweed what the Homestead Act was to American immigrants—opening up new frontiers. Since nature abhors a vacuum, so to speak, aquatic areas cleared of water hyacinth soon were filled just as densely by alligatorweed. The recalcitrant alligatorweed forced the Corps to seek new methods of weed control because none of the old methods worked.

Alligatorweed gets its name from its ability to form floating mats so dense and buoyant they can support alligators basking in the sun. In the United States alligatorweed reproduces only vegetatively, unlike water hyacinth, which reproduces both vegetatively and by seeding itself. A single alligatorweed plant reproduces many others by sending out new shoots from each

The cost of running a mechanical harvester at the Shell Creek Reservoir as recently as 1971 points out the economic disparity between the two types of controls. The harvester cost well over $500 a day to operate and after several months of use had cleared only 21 of the 900 acres of water hyacinths blanketing the reservoir.

Such modern gadgetry as lasers fared no better. In 1968 researchers at Redstone Arsenal in Alabama trained the world's most powerful CO_2 laser beam, capable of burning holes through brick, on the water hyacinth. The results were not as devastating as one might expect. Instead of vaporizing the plants, the laser ray left them undamaged to the naked eye, killing them only through injury to their photosynthetic tissues, called plastids. The bulk of the water hyacinth plant, approximately 95 percent water, was left intact because the water absorbed almost all of the laser's brick-boring heat. Like the mechanical controls, the laser also failed to stop the next generation from growing back. The Redstone laser is currently working at a job more suited to its talents, welding auto bodies in a car factory.

Mechanical removal eventually gave way to herbicides. Air boat is shown here spraying water hyacinth with 2,4-D on a section of the St. John's River in Florida.

closely spaced node along its floating stem. The new shoots inch out over the water away from the bank. Small floating islands are sometimes formed when patches as large as an acre tear away from the main mat. A lake can become so blanketed by alligatorweed that it will eventually look more like a meadow deliberately sown with some species of ground cover than a body of water. Windblown dirt and humus can take root, enlarging the floating mat. Where the alligatorweed is left untouched, dead plants sinking to the river or lake bottom speed up eutrophication. Eventually, the substrate builds up to the point where it completely fills in the lake, forming solid land.

The swelling population of man, with its concomitant rise in organic and industrial waste products, has been like a horn of plenty to both the water hyacinth and alligatorweed in recent years, providing them with a super abundance of nutrient rich waters. Unlike water hyacinth, which is restricted to the hot moist climates of Florida and Louisiana, alligatorweed infestations extend farther north to an invisible boundary line that stretches diagonally from Virginia to Texas. Alligatorweed can also exist in the more saline, brackish waters of coastal marshes as well as the fresh water of inland waterways.

Never as plentiful as water hyacinth, even after the hyacinth population was reduced by 2,4-D, alligatorweed is still a sizeable problem. Back in 1963, for example, water hyacinth infested between 1 and 2 million acres of water compared to only about 250,000 acres of alligatorweed. Alligatorweed, however, proved to be resistant to 2,4-D—and mechanical chopping merely scotched the snake since each of the closely spaced nodes on the stems was capable of generating a new plant. If water hyacinth was seen as a large fire that was being held in check, alligatorweed had to be viewed as a small but growing fire that threatened to blaze out of control.

Another approach seemed necessary, perhaps one borrowing from nature's own arsenal of plant control. In 1959 the Corps teamed up with the Special Parasite Introduction Unit of the Entomology Research Division in the United States Department of Agriculture (USDA) to search for an insect that would eat and thereby control alligatorweed by attacking it as a source of food. The Corps provided the research funding, hoping to adapt the laboratory results to a viable program of alligatorweed control.

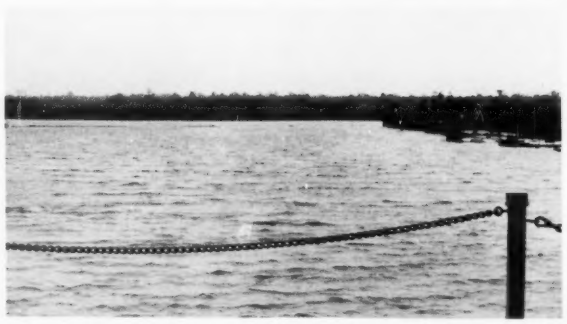
USDA researchers visited the alligatorweed's native habitat in Paraguay, southern Brazil and northern Argentina to locate host specific insect enemies—those that would attack only alligatorweed. The researchers studied 40 different species of insects feeding on alligatorweed. The most promising one was a small, 0.2-inch-long flea beetle that turned out to be a very picky eater, preferring to starve to death rather than eat anything besides alligatorweed. It was the extreme pickiness, or host specificity, of this flea beetle, along with its hearty appetite, that helped keep South American waterways clear of alligatorweed.

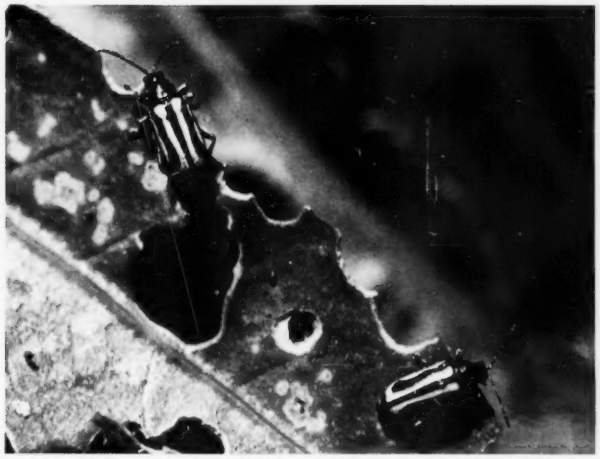
At each stage of its life cycle the alligatorweed flea beetle *(Agasicles hygrophila)* attacks a different part of the plant. Mature beetles deposit their eggs on the undersides of the leaves, where the young larvae hatch and feed. When they mature, the larvae crawl down from the leaves and chew their way into the hollow stem of the alligatorweed to pupate. (Pupation is the metamorphosis of larvae into adult insects.) This dependence on the alligatorweed's hollow stem for pupation indicates how intimately the flea beetle life cycle is tied to the alligatorweed plant.

After metamorphosis into an adult, the flea beetle chews its way out of the stem, sometimes cutting it in half, and moves to the leaves of the same or a nearby plant to feed. Eventually, the beetle kills the alligatorweed or so weakens it that waves, wind, disease or competition from other plants will finish the job.

Outside of Louisiana and northern Florida, the areas most similar in climate to its native central South America, the flea beetle does not fare so well. Although alligatorweed is really a problem along the North Carolina reaches of the Atlantic Intracoastal Waterway, for example, the beetle has had no appreciable effect there, since it flourishes only within a narrow temperature range of 60 to 75 degrees Fahrenheit.

Before and after views, one month apart, show temporary effect of spraying water hyacinth with herbicide.





Introduction of flea beetles from South America, shown munching on leaf of alligatorweed, may control infestations of aquatic weed better than earlier methods.

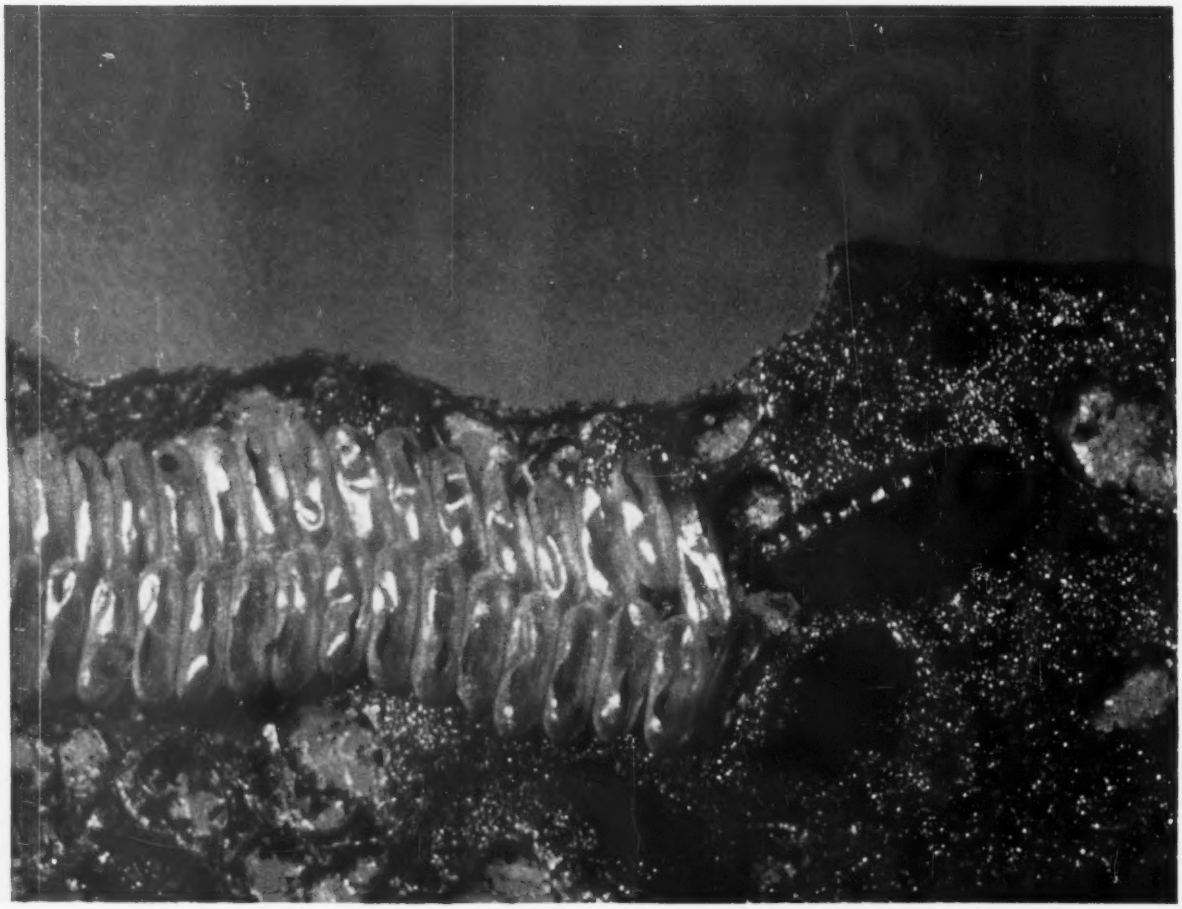
Thickness of alligatorweed mat is evident as Agricultural Research Service entomologist walks on water to collect beetle specimens.

The problem is that the flea beetle does not hibernate in the winter and must, therefore, continue to eat. Thus, when the alligatorweed dies down to the water line during the cold winter weather mass starvation ensues. When the temperatures climb into the 90s during the sweltering summer, the spring rise in the beetle population slows and does not regain its impetus until autumn when the temperatures again drop below 75 degrees. Because of these fluctuations in its reproduction and death rates throughout the yearly cycle, the flea beetle population never becomes large enough to eliminate the alligatorweed.

Several other factors have limited the flea beetle's success. First, the flea beetle's survival is precariously dependent on the nutrient content of the alligatorweed it eats; if the nutrient content is not high enough, the flea beetle dies from malnutrition. Secondly, insecticides meant for mosquitoes do not discriminate between mosquitoes and flea beetles, killing them both—just as herbicides applied to the water hyacinth also destroy nearby food crops. Finally, whenever the water levels of infested rivers and lakes rise to a point where they immerse the tops of the alligatorweed, the flea beetle population drowns.

The next step was a refinement in the control program initiated by a scientist's chance observation along the Ortega River in Florida. He noticed the effect of the flea beetles on the alligatorweed was enhanced wherever 2,4-D was sprayed on adjacent mats of water hyacinth infestation. This prompted the development of what became an "integrated" control approach, so called because it combined chemical and biological controls into one procedure. Under the new technique, the 2,4-D killed off most of the alligatorweed above the water line and the beetles prevented it from growing back at its former rate, which had previously rendered the herbicide useless. With integrated control it took only half the time—18 months—to clear a waterway. Though it worked faster, integrated control still required periodic applications of 2,4-D.

Eggs laid on alligatorweed leaf hatch larvae, which bore into hollow stem of plant to pupate.



By now it was apparent the only permanent method of control would have to be wholly biological. The potential advantages over other types is that once a biocontrol is administered to an infested area, its original dosage, unlike herbicides, automatically increases as the insect population grows. Ideally, after the initial release, the insects should disperse under their own power to seek new stands of the host plants.

Therefore, a second insect out of the original 40 species studied in South America was introduced a few years after the flea beetle. A thrips *(Amynothrips)* showed promise but was unable to build up an effective population and, because it could not fly, its dispersion was negligible. However, a third insect, a stem boring moth *(Vogtia malloi)* was introduced in 1971 and made the success of biocontrol complete. Possessing a much wider temperature range than the flea beetle, *Vogita* can survive the cold winters and continue to reproduce during the hotter days of summer, complementing the flea beetle in areas where the latter is already established.

Ten years after the beetle-moth combination was begun in the Ortega River, alligatorweed is no longer a pest. "Alligatorweed is now an accepted member of the plant community," according to Neal Spencer, a USDA entomologist who worked with the flea beetle and is currently developing a similar biocontrol program for the water hyacinth. "It has lost its weediness."

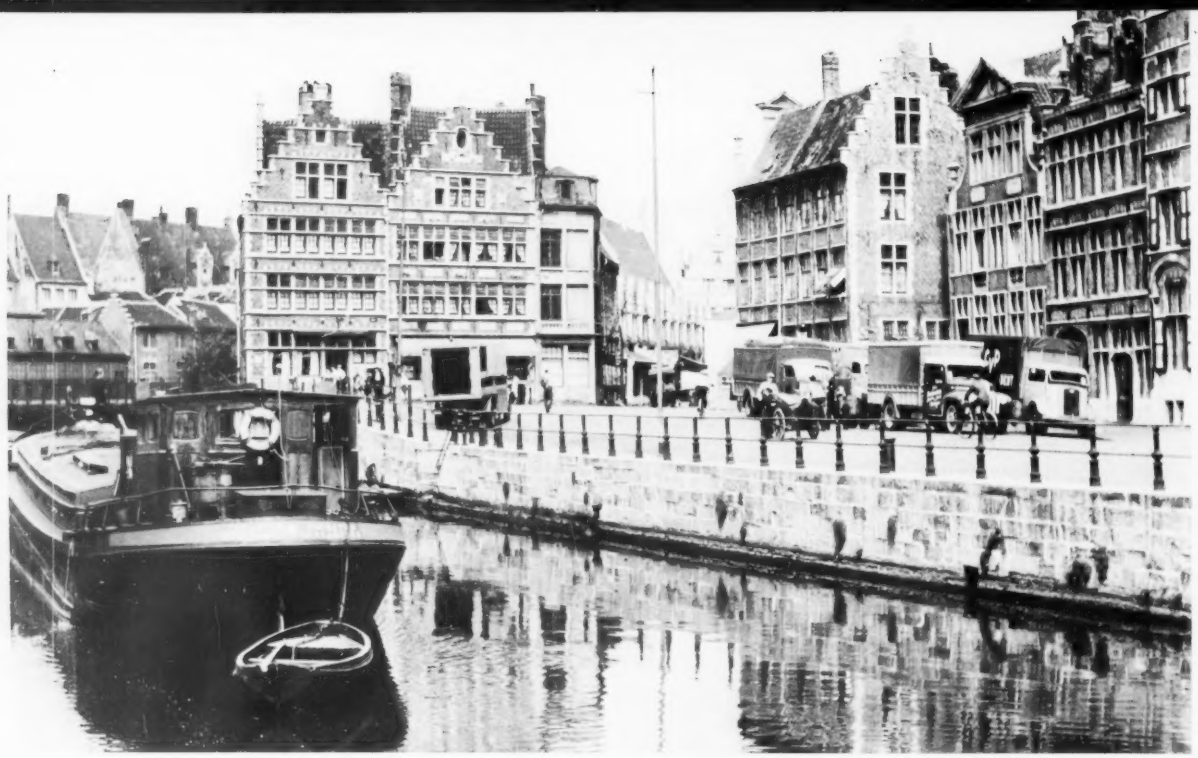
For some reason there has not been much migration of other weeds such as hydrilla, smartweed and Eurasian watermilfoil into vacated areas. A possible deterrent may be the fact that the insects leave alligatorweed intact along the banks, thus preventing other plants from gaining a terrestrial foothold along the edge of the water. This is not necessarily desirable, since occasional invasions of a new plant sometimes bring unexpected benefits. Smartweed, for instance, is a favorite food of ducks, and its presence usually guarantees excellent duck hunting.

With the eradication of alligatorweed as a pest, water hyacinth has regained its old number one ranking. Researchers from the Corps, USDA and several southern universities focused their energies on finding a biocontrol for the water hyacinth using the same techniques they had developed in fighting alligatorweed. They located insects feeding on the water hyacinth in its native central South American rivers and lakes, screened out those that also attacked other plants and brought back only those that were host specific to the water hyacinth.

The first insects imported from South America and released in the United States were two water hyacinth weevils *(Neochetina eichorniae* and *Neochetina bruchi).* The initial releases were made in south Florida in 1972 and 1974 with encouraging results; however, these weevils have not yet reached population sizes large enough to make an impact on the approximately 1.5 million acres of water hyacinth infesting the Southeast.

In case the weevils do not live up to expectations, other biological controls—both insects and microorganisms—are being studied. Even as there was a progressive refining process in the earlier unsuccessful attempts at mechanical control, from Rube Goldberg-type crushers and destroyers to Buck Rogers-type lasers, there seems to be a similar move toward more scientifically elegant solutions within the development of biological controls. Researchers at the University of Florida are currently experimenting with plant pathogens, specifically fungi, that could some day conceivably destroy entire water hyacinth populations with the deadly speed of an epidemic.

Whatever the final control, researchers estimate from the amount of time it took to control alligatorweed after the first introduction of the flea beetle, about 10 years, that the water hyacinth weevils should have the pretty little plants with pastel colored blossoms and heart-shaped leaves under control by the early 1980s—about 100 years after the water hyacinth was first welcomed to the United States.□



Water Problems in Belgium

The following article discusses how a country so small it must share its water basins with neighboring nations establishes its national water resource goals to compensate for anticipated national growth. This is part of a continuing series from PIANC member nations.[1]

by Professor Engineer J. Verschave

A population on the increase, coupled with progressive pollution of its rivers and waterways, is creating national water problems for Belgium. The nation has divided its search for solutions into three separate approaches, each involving international considerations.

The first approach is to build additional reservoirs and retarding basins to increase the available supply during periods of low rainfall. The second is a planned program of increasing the number of water treatment facilities to upgrade water quality, making more of the water available for multiple uses. The third is recycling of Belgium's polluted waters in order to permit their reuse several times over before they leave Belgium.

Belgium is a nation of three distinct hydrologic basins, all three beginning to her south in the hills of northern France. Two of them drain into estuaries located in the low-lying Netherlands to the north, the third empties directly into the North Sea from the Belgian coast. Each basin is known by the name of its principal river, which flows in a northerly direction from France into Belgium.

The highest ground in Belgium is within the easternmost basin, where the Meuse is the major river; however, the highest point is only 680 meters (2,244 feet) above mean sea level. This river reaches the North Sea through the Netherlands.

To the west of the Meuse basin, the Scheldt River drains the middle of the country. At Ghent, the Scheldt becomes a tidal river and is joined by the Lys, which also originates in France. Beyond Ghent the tidal Scheldt flows north past the port of Antwerp and down into the Netherlands, where it meets the Scheldt estuary before entering the North Sea.

The French hills in which the Meuse, the Lys and the Scheldt originate are generally less than 200 meters (660 feet) above mean sea level; the Belgian valleys through which they flow are below 50 meters (165 feet) in altitude.

The even lower altitude coastal region, consisting of polders (low-lying land reclaimed from the sea) and the western parts of Flanders, is drained by the Yser, a river made famous by several World War I battles. The Yser empties into the North Sea at Nieuport, while other lesser rivers in this basin also drain directly into the sea at the ports of Ostende, Blankenberge and Zeebrugge. The sources of the Yser are in the coastal hills of northern France, where the average altitude is only 50 meters (165 feet) above mean sea level; however, the

[1]The Permanent International Association of Navigation Congresses exchanges professional papers on water resource developments among the member nations and holds international congresses quadrennially. See article on PIANC in Winter 1975 issue of *Water Spectrum*.

Belgian coastal basin through which it flows drops below 10 meters (33 feet) in altitude.

The only source of water actually originating in Belgium comes from precipitation, which averages about 850 millimeters (34 inches) a year. About 500 millimeters (20 inches) of this returns to the atmosphere through evapotranspiration.[2] The amount of rainfall retained through runoff into storage basins, by infiltration into artesian wells or through percolation into subterranean aquifers is only 350 millimeters (14 inches) a year.

Thus, the annual volume of water available from rainfall within the 30,000 square kilometers (over 11,580 square miles) that make up the country of Belgium is about 10.5 billion cubic meters (2.77 trillion gallons). The average daily runoff resulting from that volume of rainfall measures 28.7 million cubic meters (7.58 billion gallons). This runoff joins the network of rivers within each basin steadily increasing their flow rates as they course down through Belgium to the sea.

Some visual idea of the approximate boundaries for the three major basins requires a look at the accompanying map of Belgium. The easternmost basin drains a combined area of 20,800 square kilometers (8,029 square miles) in both France and Belgium. Starting as the Meuse in France, its principal river enters the Netherlands as the Maas.

The Scheldt basin extends over an area of 19,500 square kilometers (7,527 square miles) in both northern France and Belgium. Both the Scheldt and Lys Rivers combine at Ghent, where the tidal Scheldt begins. Only about 60 percent of the combined flows from the upper Scheldt and Lys are allowed to continue beyond Ghent into the tidal Scheldt and thence to the Scheldt estuary in the Netherlands. The other 40 percent is diverted into three canals that angle off toward the North Sea and the West Scheldt.

The 60 percent allowed to continue into the tidal Scheldt is augmented between Ghent and Antwerp by fresh water flows from the Durme, Dender, Rupel and Nethe tributaries. Below Antwerp this fresh water begins to mix with the salt water from the Scheldt estuary.

The Yser coastal basin drains 2,300 square miles within Belgium. For the comparative flow rates of the rivers as they enter and exit Belgium see the accompanying table 1.

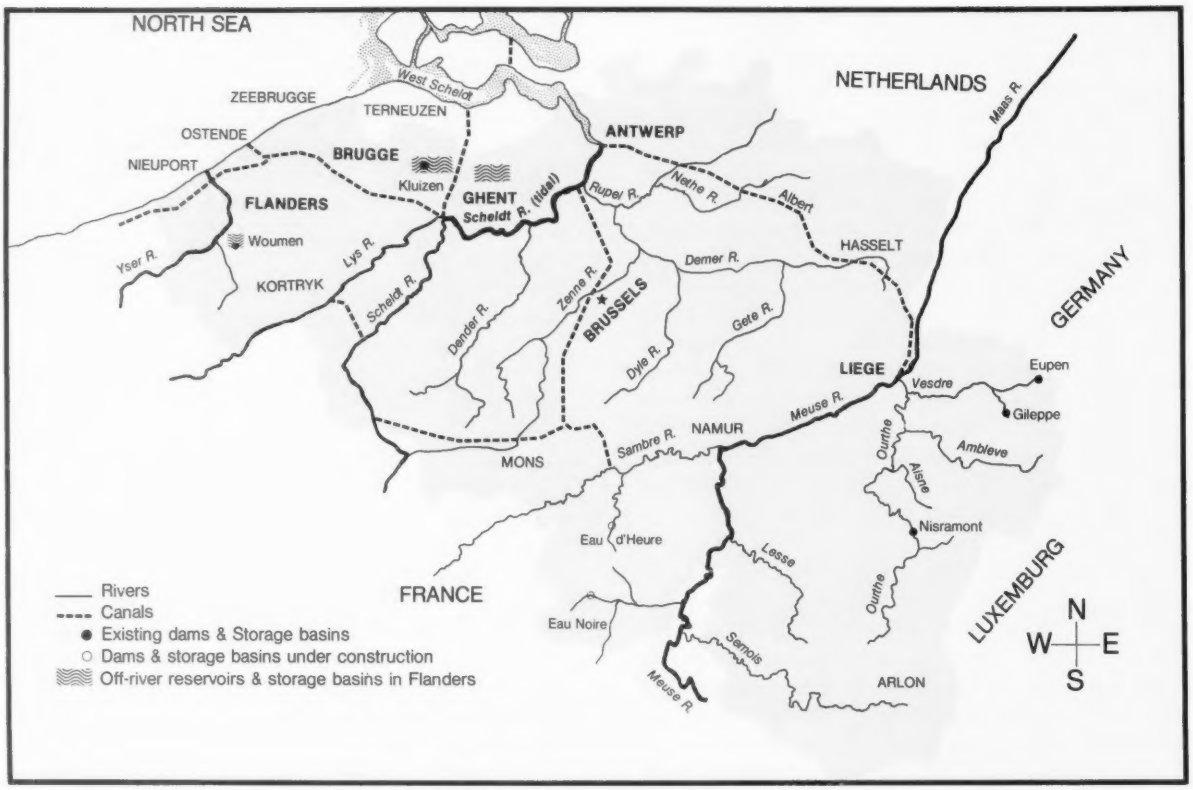
During the very dry summer the coastal basin dries up and the discharge level for the whole country may drop as low as 3.6 million cubic meters (951 million gallons) a day. Thus, during periods of low flow, the average runoff from rainfall is not actually available. During flood periods, on the other hand, volumes exceeding 259.2 million cubic meters (68.5 billion gallons) a day pour into the Netherlands and the North Sea so rapidly that Belgium receives no benefit from these heavy flows.

Although available supplies of water are uncertain and extremely dependent on seasonal variation in rainfall, the daily demands remain fairly constant. About 2.35 million cubic meters (620.8 million gallons) are needed to maintain navigable water levels in rivers and canals; 250,000 cubic meters (66.04 million gallons)

[2] The process which pulls water through plants by the suction created from evaporation off the leaves.

Meuse River drains the highest of Belgium's three basins.

(c) National Geographic Society



Belgium's principal rivers start in the hills of northern France and flow northward toward the Netherlands and the sea.

a day must be available to compensate for water lost through surface evaporation; and industrial needs draw off still another 150,000 cubic meters (39.6 million gallons) that are not returned to the waterways. This adds up to 2.75 million cubic meters (726.5 million gallons).

Belgium's population of 10 million inhabitants currently consumes 1.2 million cubic meters (317 million gallons). Added on to the daily needs of industry and the waterways, this adds up to a daily requirement of 3.95 million cubic meters (1.04 billion gallons).

The daily volume of water for private consumption is provided by three major sources: ground water from artesian wells and springs provides 625,000 cubic meters (165.1 million gallons); reservoirs formed by damming rivers in the Meuse and Scheldt basins contribute 150,000 cubic meters (39.6 million gallons); and another 425,000 cubic meters (111.2 million gallons) is drawn off rivers and canals into settling basins prior to treatment. This meets the daily need of 1.2 million cubic meters (317 million gallons) for private consumption.

For the daily needs of industry and the waterways, which is 2.75 million cubic meters (726.5 million gallons), there is only 2.4 million cubic meters (634 million gallons) available, a deficit of 350,000 cubic meters (92.5 million gallons).

There would be a sufficient volume of water to meet these needs except that the water lost due to progressive pollution as it flows downstream and the lack of water purification equipment in Belgium requires draining the polluted water into the tidal Scheldt and the North Sea instead of recycling it. Most of the Nation's polluted waterways are within the Scheldt basin, but increasing amounts of industrial wastewater and sewage from the various population centers have been contributing to contamination of all the waterways and rivers at a steadily increasing rate ever since the economic expansion that began in Belgium after World War II. Some of these waterways become dead biologically during the dry summer months when the lowered flow rates drop the oxygen present in the water below the levels necessary to support aquatic life.

The practice of eliminating polluted bodies of water as quickly as possible requires increasing the discharge rate by augmenting low flows with precious water reserves released from the storage lakes and reservoirs. Only a huge investment in sewage treatment and water purification plants can reduce this loss by making it possible to recycle treated wastewater back to Belgian waterways.

There are, however, several factors which help to balance the daily deficit. One is the extended system of canals, measuring 1,560 kilometers (936 miles) in total length, that interconnects the river basins. The Albert Canal, for instance, is useful in transporting unpolluted water from the Meuse to satisfy the needs of the

Eau d'Heure Dam will add to the Meuse basin's storage capability when completed.

Eupen Dam on the Vesdre and Gileppe Dam on the Gileppe are two of the existing lakes built to supplement water supply in the Meuse basin.

Table 1

BELGIAN WATER DISCHARGE LEVELS
(Cubic Meters/Second)

River Basins	French Border	Dutch Border	Belgian Territory
Meuse			
min.	5	27	22
avg.	70	270	200
max.	600	2900	2300
Scheldt			
min.	10	30	20
avg.	60	180	120
max.	320	665	345
Yser			
min.	0	0	0
avg.	5	15	10
max.	30	170	140

Antwerp metropolitan area. Pipelines also transport some of the Meuse water into Brussels, Ghent, Brugge and the Belgian coastal region. Meanwhile, water from the upper Scheldt and Lys Rivers helps maintain the minimum water levels to operate the canals in the water-starved Yser basin during the summer.

Another favorable factor is the existence of manmade reservoirs and storage basins that are refilled during the winter months. These form reserves for the drier months and provide a year-round elasticity in the distribution process.

Future water problems will arise, however, due to the ever increasing demands for more household usage, more consumption by industries and a larger navigation requirement caused by the deepening or enlarging of some canals. The Albert Canal is to be enlarged and deepened between Liege and Antwerp to accommodate pushtows that can carry up to 9,000 metric tons (9,900 short tons). The entire canal network between these two cities in northeast Belgium carries the country's highest annual tonnage. Improvement programs planned to assist traffic movement on the Lys River and the Ghent-Brugge Canal also will require supplemental water.

Future waterways requirements may rise to an estimated daily volume of 3 million cubic meters (792.5 million gallons) in order to meet predicted navigation needs in maintaining consistent water levels. Add another quarter million cubic meters each to compensate for evaporation losses and future industrial consumption and the estimated volume increases to 3.5 million cubic meters (924.6 million gallons) a day. Compare this amount with the volume of 3.6 million cubic meters (951

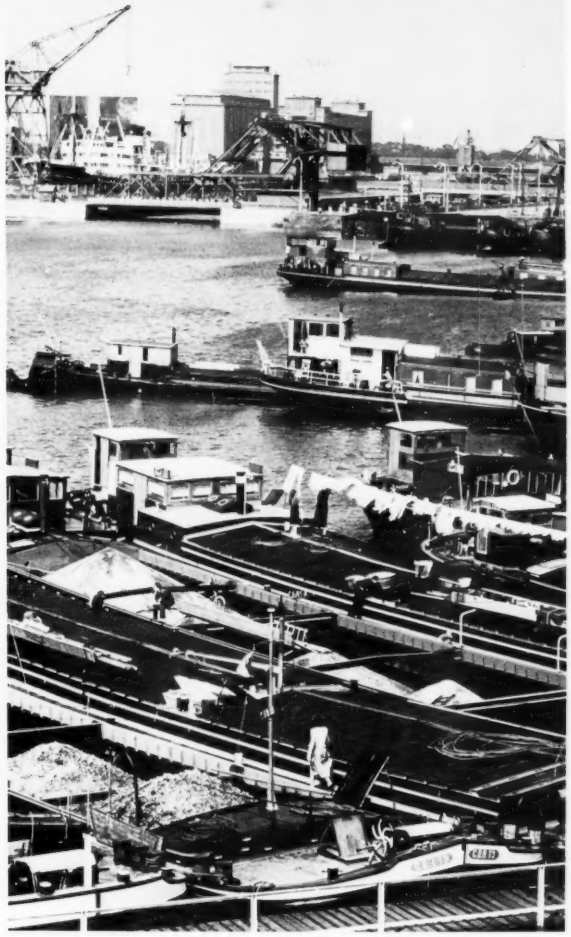
Table 2

ESTIMATED FUTURE DAILY DEMAND
(Cubic Meters/Day)

Maintain water level in rivers and canals	3.0 million (792.51 million gallons)
Compensate for private consumption	3.0 million (792.51 million gallons)
Compensate for evaporation	250,000 (66.04 million gallons)
Compensate for industrial needs	250,000 (66.04 million gallons)
	6.5 million (1.7 billion)

Future Daily Pumpage Rates to Produce Extra 3 million m^3/day

Ground Water	625,000 (165.1 million gallons)
Reservoirs & Retarding Basins	600,000 (158.5 million gallons)
Rivers & Canals	1.8 million (475.5 million gallons)



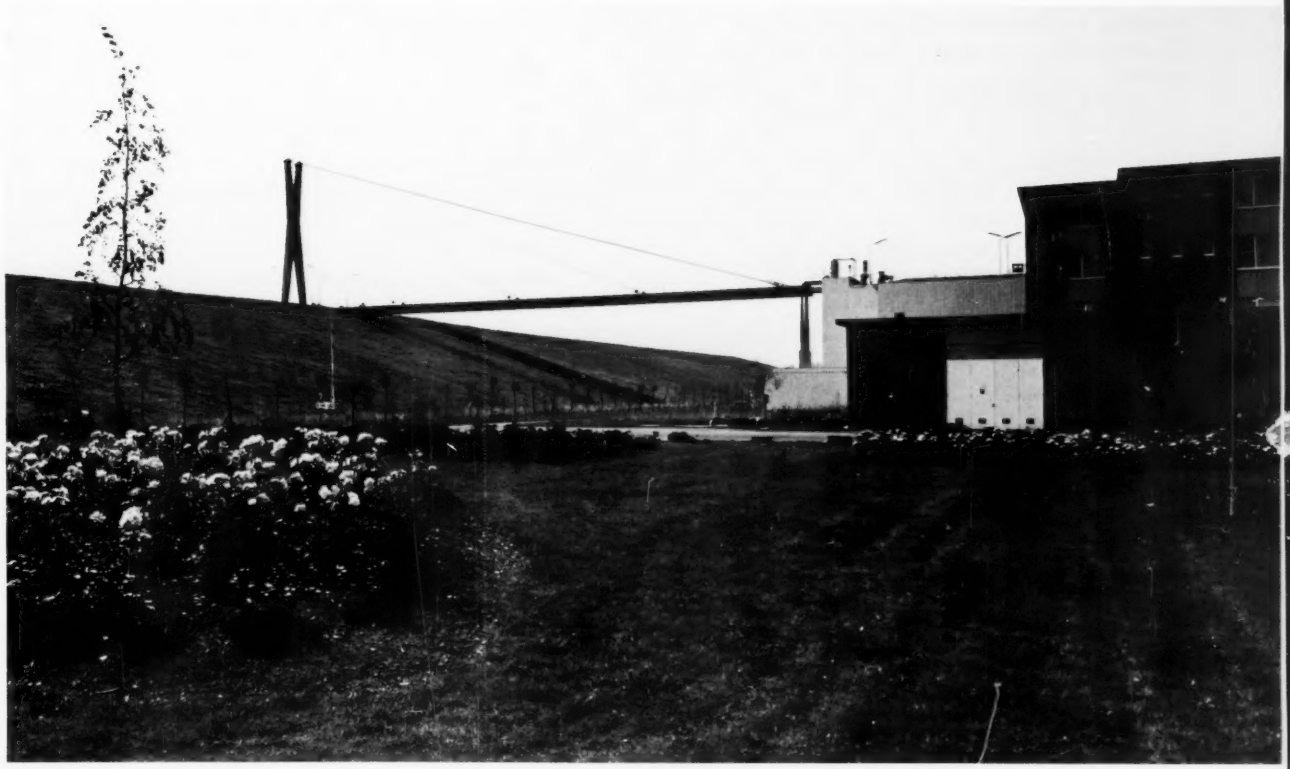
million gallons) available daily and it becomes clear that any other demands for water, which can simultaneously climb to an additional 3 million cubic meters (792.5 million gallons), cannot be met if large quantities of polluted water are permitted to remain untreated and pass on to the sea. Table 2 shows that the estimated future daily need could reach 6.5 million cubic meters (1.7 billion gallons).

The only solutions are the increased use of sewage treatment, construction of wastewater purification facilities and the creation of reserve supplies to supplement ground-water fed springs and artesian wells which have reached their ultimate yields.

More than two-thirds of Belgium's wastewater will have to be returned to her waterways for reuse. The international implications of recycling the polluted water rather than discharging it to the sea creates a new set of problems. Belgium receives most of her polluted water from the upper Scheldt and Lys Rivers and occasionally from the Yser. Belgium, in turn, delivers polluted water downstream to the Netherlands—mostly from the tidal, or lower part of the Scheldt River.

Family operated pushbarges bound for inland ports tie up in Antwerp Harbor near downstream entrance to Albert Canal. (c) National Geographic Society

Water supply in Scheldt basin is augmented by this diked impoundment and treatment plant at Kluizen, north of Ghent.



Dutch authorities would prefer to continue receiving a substantial volume of good quality water from the normal flow of the Meuse and have asked the Belgian government to limit the quantity of water diverted into the Albert Canal, through which it is transferred into the Scheldt basin at Antwerp. In accordance with the Benelux Economic Union Treaty of 1958, Belgium and the Netherlands have negotiated an agreement concerning the exact quantity and quality expected from both the Meuse and the Scheldt at the points where those rivers cross the Dutch border.

Plans also are underway to construct new dams and reservoirs on several tributaries of the Meuse and thereby create supplementary lakes that will raise total storage capacity to 240 million cubic meters (63.4 billion gallons). This, in turn, will increase the river's year-round minimum flow at the town of Monsin, downstream of Liege, to a rate of 50 cubic meters (13,208 cubic gallons) a second by January 1, 1982.

Meanwhile, negotiations with French authorities have led to a program of improvement now underway in both countries to enhance navigation and discharge levels on the Scheldt River. Planning studies have been made on the feasibility of installing several sewage treatment and water purification plants within the industrial regions of Valenciennes and the Lille-Roubaix-Tourcoing triangle in northern France. Some of the plants are in operation, others are being built, and construction of a third group will start soon. Such measures will progressively improve the quality of water entering Belgium territory from the Scheldt and Lys Rivers until a high degree of purity is reached in 1987.

The author is Secretary General of Belgium's Ministry of Public Works as well as a professor at the University of Ghent.

To help achieve this goal, Belgium set up a program in 1973 to construct sufficient sewage treatment and water purification facilities to service up to 6 million inhabitant-equivalents. The national budget contains an annual investment of 2 billion Belgian francs ($50 million) for this purpose. The improvement program for the Scheldt basin (including the cities of Antwerp, Brussels and Ghent) is considered the most urgent and is currently in full operation.

Also, a bill proposed by the government of Belgium would impose severe regulations and controls on the discharge of industrial wastewater and cooling waters into waterways. This proposed bill would require that new industries plan, finance and build the necessary pollution control equipment themselves, but would provide existing industries with access to financial aid from the government in order to help them modify and update their equipment in compliance with the new regulations. The above mentioned steps are intended to help Belgium win the battle against pollution and poor water quality.

Belgium's national aim is to completely clean up her waterways, canals and rivers by 1987 while continuing to meet all demands for water to support navigation, irrigation, industry and household uses. The results will be watched by other member nations of PIANC, especially those whose river basins extend beyond their own borders. □

Cost of achieving Belgian goal amounts to about $700 million (14 years x $50 million/year), to be financed through long term national loans.

Hy·dro·struc·tures* Colonize the Deep

* **Hy·dro·struc·ture** (Hī'drō, hī'drs, + struk' chĕr) [<Gr. Hydōr, water + L. structura < structus, PP. of struere, to heap together, arrange; cf. strew], 1. manner of building, constructing or organizing in water, 2. something built or constructed in the seas or oceans as in the construction of artificial reefs, 3. any manner of manmade submarine habitat constructed to furnish shelter and attachable surfaces for marine organisms, 4. the fabrication of an artificial underwater sanctuary for the promulgation, preservation, conservation or harvest of food from the sea, —SYN. see **MARICULTURE, CONSERVATION.**

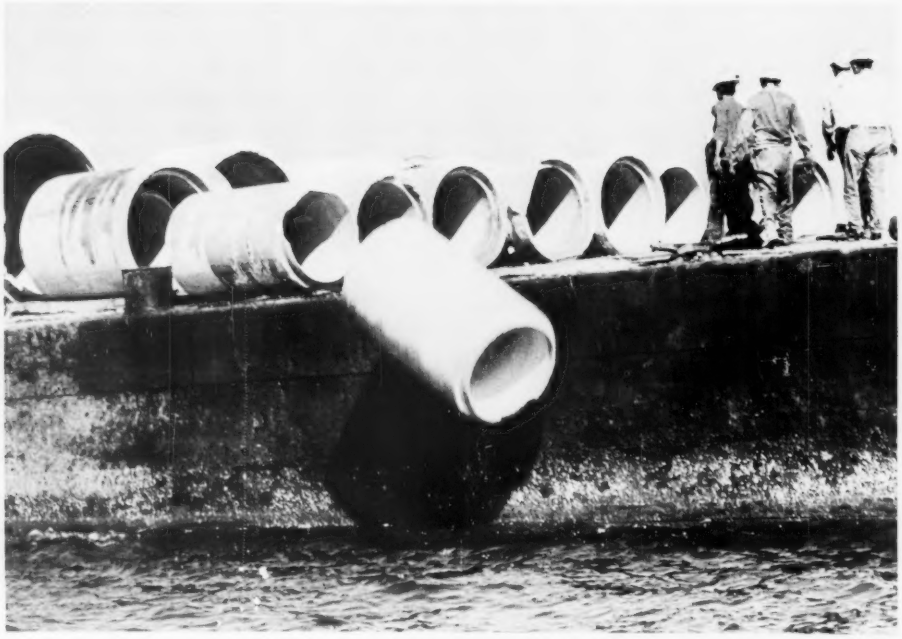
by John C. Fine

Webster's lexicographers may or may not take kindly to the above method of defining *hydrostructure.* They may even coin a better word at some future time for what it describes. Whatever "it" is actually called—today or tomorrow—there must be some word that can verbalize the need for planting structures in the seas that will insure continuance of an ample food supply and preservation of spawning grounds for countless marine species. Otherwise, these species will be "selected out" of existence in the fierce battle for survival in aquaspace.

Disconcerting headlines report the demise of magnificent undersea coral gardens, the destruction of traditional breeding grounds and the disappearance of great numbers of undersea fauna through pollution and overharvesting; they proclaim the inevitable death of our ill-fated oceans. Meanwhile, much has been happening, albeit in a very quiet way, that promises to reverse the trend by artificially providing living space for aquatic creatures that otherwise would be forced to vie with each other over a limited number of undersea habitats. Although everything has its place in nature, there is not necessarily place for everything.

Having a home means survival for thousands of marine species of plants and animals, since space is such a precious commodity in our seas and oceans. Recognizing that we do not yet have all the answers about *hydrostructure,* or the building of artificial submarine reefs, we have begun drawing on the collective wisdom and experiences of various Federal, State and local conservation groups and commercial fishing interests to undertake such building projects. Recent reports have been universally optimistic and encouraging. Initial attempts, however, were as haphazard and arbitrary as they were innovative and novel. Well meaning amateurs began reef building by dumping all manner of scrap into the water—ranging from defunct refrigerators and air conditioning units to broken plumbing fixtures, junked car bodies and worn out rubber tires. The selection was not much different from what the mass of *unreeformed* litterbugs were throwing into the oceans before the practice became fashionable. The fish, barnacles and anemone did not seem to object since, as every oceanographer knows, "everybody's got to be someplace."

In addition to being an attorney and consultant to the U.S. Senate, the author is a Nationally Certified Scuba and Research Diving Instructor and a French National Underwater Instructor.



Imperfect roadway culverts are rolled into Gulf of Mexico to become beginnings of underwater reefs.
Texas Parks & Wildlife Dept.

Australian divers jump from a work barge into Port Phillip Bay at Melbourne to position concrete-filled tires into artificial undersea reef.
Victoria Dept. of Fisheries & Wildlife

Although the undersea creatures seemed to thrive on this junk habitat, Congress acted to regulate the dumping of alien materials into the oceans and other bodies of water under the Marine Protection, Research and Sanctuaries Act of 1972. Under this legislation the Administrator of the Environmental Protection Agency (EPA) must conduct public hearings before issuing permits for dumping. Each permit applicant must show that such dumping will not unreasonably degrade or endanger human health or welfare or the marine environment, any ecological systems or the economic potentialities of the seas.

This act, however, exempts from EPA regulation the construction of any fixed structure or artificial island that would not be considered as the simple dumping of waste material into the water. Placement of a fixed structure, such as the building of an artificial reef, requires a permit from the U.S. Army Corps of Engineers under Section 10 of the 1899 River and Harbor Act. This section prohibits the unauthorized obstruction or alteration of any navigable water of the United States. Corps authority was extended to artificial islands and fixed structures located offshore through section 4 (f) of the Outer Continental Shelf Lands Act of 1953. The same legislation, however, also makes special provision for the establishment of offshore marine sanctuaries in order to preserve or restore such areas for their conservation, recreational, ecological or aesthetic values.

Under this legislation, which is aimed at the more inimical forms of ocean dumping, the once haphazard construction of artificial reefs off the United States by a handful of local divers and diving clubs has become a carefully regulated procedure that not only insures the

Author examines 30-year marine growth on encrusted bow gun of warship sunk at Truk in the Eastern Caroline Islands of Micronesia.

projected reef will provide some substantial value but also protects other interests—such as navigation.

In the days before regulation, we often weighted old automobile tires with heavy stones and swam with them to the ocean bottom off the Long Island or New Jersey Coasts, then returned in a few weeks or months to watch underwater life take hold. Algae, anemone, barnacles and mussels attached themselves to the newly created undersea niches and, in turn, attracted fish and lobster. What we were doing in those early, unregulated days was using common sense derived from the knowledge of the fisherman that life abounds on or around shipwrecks, rocks, reefs or any other underwater protuberance that will provide a hold. Experience taught us that while the best reef building materials could be the cheapest and easiest to obtain, they also had to be those materials which would not deteriorate under the sustained attack of subsurface sea water.

There are vast reaches of barren space in the undersea structure of our oceans. Large areas of the continental shelves that extend outward from North America and many of the other continents consist of sandy bottoms devoid of undersea habitation, simply because there is no place to hang onto for marine life. There must be some attachable surface for the builders of a marine colony to anchor and thus form the nucleus of an underwater village. In theory, most anything can serve as that anchorage. The tiny barnacle, for example, will accept any port in a storm, so to speak, and stick to most any surface. The tiny coral polyp, mighty builder of the depths, requires a more substantial anchorage upon which to grow and form its marine colony. Once formed, however, well established coral reef can exist for eons, eventually expanding into a natural continental barrier in the warmer waters of the world.

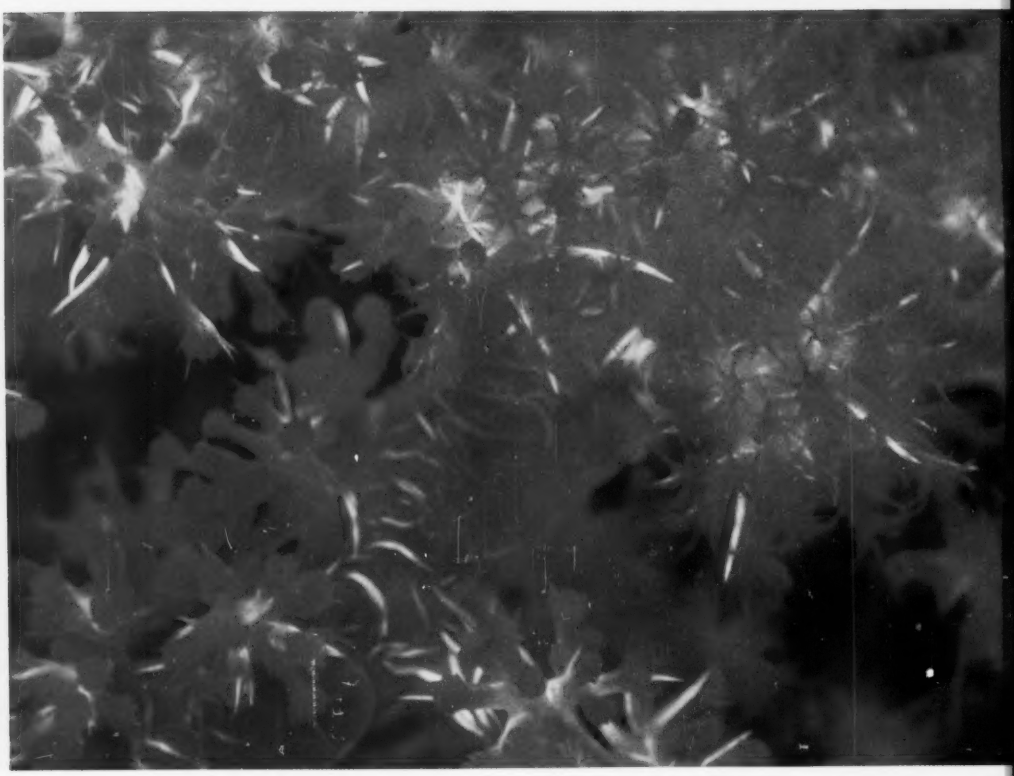
Ironically, the traditional artificial reef received its start from the unintended side effects of World War II. This beneficial aspect of that war's legacy went unnoticed until relatively recently—except for a handful of underwater explorers, treasure seekers and the most astute of commercial fishermen.

Wrecks of ships torpedoed during the war have been providing havens for a myriad of underwater life during the more than 30 years that have passed. These old war wagons, every available niche overgrown by marine flora, house the builders and producers, the phytoplankton and the small plankton feeders that support the larger eaters.

Nature has transformed underwater memorials of death and destruction into life sustaining shelters. When one considers that man derives 70 percent of his oxygen from marine plants and that food from the sea accounts for a large percentage of his diet, this fact of nature should be reckoned with in a more positive manner. Why should it be necessary to rely only on the guns of war to turn old battlefield memorials into productive marine environments?

Such introspective thinking led the Alabama Department of Conservation to suggest that the United States make its surplus World War II Liberty ships available to the State governments for the construction

Coral polyps thrive on masts of sunken Fujikawa Maru.



of artificial reefs. With the help of congressional sponsors, the State of Alabama received five of these ships, which were sunk on May 2, 1974 to create a reef for snapper fishing.

Prior to qualifying for receipt of these ships, the Alabama Department of Conservation and Natural Resources had to obtain Corps permits under section 10 of the 1899 River and Harbor Act and coordinate with commercial fishermen to preclude any possibility that these ships could become hazards to navigation. To answer that requirement, they were stripped down and then cut to a vertical height of 15 feet. Not only did this remove the navigation hazard, but the scrap value of the dismounted superstructures also paid for the cost of the project.

The remaining 416-foot-long by 50-foot-wide hull also had to be cleaned of all oil and debris in order to pass EPA and State standards for water quality prior to sinking.

The first of these cut down ships, still weighing approximately 1,000 tons, was towed into a position about 12 miles off Perdido Pass outside of Mobile Bay and sunk in 85 feet of water. The explosive charges were placed by demolition teams from the U.S. Navy. Six years after, the fishing is reported to be excellent over this wreck. Among the species found in abundance today are king mackerel, ling, dolphin, snapper, grouper and triggerfish.

In addition to sinking the Liberty ships, Alabama has also dropped imperfectly cast concrete culverts into Mobile Bay to attract more fish. To quote Wayne E. Swingle, Alabama's chief marine biologist: "Fish are attracted to a reef because it provides a place of refuge from larger predators and also because the food supply is increased by the invertebrate organisms that live near the reef. These organisms attract smaller fish that serve as food for larger fish. However, many fish are attracted simply because the reef provides a point of reference in a bottom habitat that is often barren as a desert. These fish are known as thigmotropic (attracted to an object by a touch or stimulus) by those who wish to complicate things."

To compensate for the lack of natural reefs off Alabama's coast, the Marine Resources Division of the State Department of Conservation and Natural Resources began an inshore reef construction program in 1971. Reefs were begun in depths of 60 to 90 feet among the estuaries of Mobile Bay by seeding with 1,250 tons of imperfect concrete building blocks and broken roadway paving. Good fishing has been reported on all the reef sites.

Shipwreck in Florida's Pennekamp State Park provides substrate for coral and invertebrates that, in turn, attract fish.

Historically, Alabama also was the first State to establish offshore marine reefs. It began in 1953 with the placing of 250 wrecked car bodies in the Gulf of Mexico and fishermen began catching snapper within 6 months. The State sank 1,500 more car bodies in 1957. Again, excellent fishing was reported after the first 6 months. The total project cost of $71,409 averaged about $41 a car body. Other successful projects followed.

Florida began a series of artificial reefs on April 10, 1968, when it sank three vessels about 3/4 mile off Palm Beach Inlet. These were the 185-foot antisubmarine escort Mizpah, a 165-foot patrol boat and the hull of the Amaryllis, a 441-foot Greek freighter beached on Singer Island as a result of being blown ashore by Hurricane Betsy. This same reef was upgraded in 1971 by sinking a 65-foot tugboat, concrete rubble and rubber tires, all of which have contributed to what is today a bountiful underwater haven for millions of marine creatures.

In Walton County, where a building block manufacturing firm donates its imperfect blocks, which amount to 50 tons weekly, Florida has followed Alabama's lead and reports good fishing above these artificially constructed reef areas.

The Texas Parks and Wildlife Department has also applied for a number of surplus Liberty ships to sink as artificial reefs in addition to seeding the offshore sea floor with scrap items.

Although wrecked car bodies have been used to some advantage in the Gulf of Mexico, it has been found that they disintegrate too quickly. Nevertheless, they have been effective on a temporary basis in sheltering marine life from the rigors of underwater currents and tides. Hydrostructionists, for this reason, have shifted to the use of imperfect concrete pipe, which is culled from construction damaged items or factory mismolds, with a great deal of success. The concrete provides a near permanent base, since it will not collapse from the corrosive action of the salt water.

Unlike scrap car bodies, the used rubber tires we associate with them provide good longevity as marine life substrates. Long the bane of every municipality, about 200 million used tires pile up in the United States annually. Richard B. Stone of the Atlantic Estuarine Fisheries Center at Beaufort, North Carolina estimates that of the 114 approved artificial reefs along the Atlantic Coast, about 43 contain some 600,000 scrap tires.

In a test area off South Carolina's Murrells Inlet, a "before" survey reported that invertebrates were of little nutritional value to local fish, of which there were only a few species. Within a few days after the tires were installed, Stone reports, encrusting organisms began to set on them.

"Barnacles that settled in July attained an average base diameter of ½ inch by November and ¾ inch by March. In fact, by spring many of the large barnacles were heavily grazed, probably by sea urchins and sheepshead. During winter, there was prolific invertebrate growth on the tire units, particularly that of hydroids and sponges. Living in or on these animals were numerous small isopods, amphipods, and polychaete worms. These invertebrates are prime food organisms for fishes . . . sheepshead and black drum, ranging in weight from 2 to 4 pounds, were seen lying in a semi-torpid state deep under the reef material . . . . It is believed that these species use the artificial habitat for shelter during cold periods. Spotted sea trout were also observed schooling and feeding around the reef material in winter. Some individuals were in excess of 27 inches in total length. As warmer months approached, portunid crabs were seen occupying the same habitat used by black sea bass, pigfish and pinfish.

"Catches from Paradise Reef have contained more and larger amberjack and summer flounder than before construction. The overall fish-carrying capacity of the area has increased 300 to 1,800 times. This reef has proved to be an effective tool for increasing fishing opportunities and maintaining high angler success in an area accessible to small boat fishermen."[2]

[2]Richard B. Stone, *Sea Frontiers Magazine*, Vol. 20, No. 1, Jan.-Feb. 1974.

Old auto tire placed at bottom of Intracoastal Waterway off Florida's Singer Island houses assortment of aquatic species.

This triggerfish guards clutch of eggs laid in piling at left.

Closeup of marine growth on scrap tires tossed into water to become hydrostructures.

Australia also is experimenting with old auto tires in a search for the most suitable hydrostructure material. Recently, large numbers of cement-filled tires, connected in a linked series, have been placed in Port Phillip Bay by the State of Victoria. The almost landlocked bay is the southern Australian city of Melbourne's playground. In other areas, cement pylons assembled into reefs resembling large toy jacks have been purchased specifically for this use. Although quite effective, they are costly to construct and transport.

The Australian Government, which is very serious in its reef building efforts, is experimenting with four basic seeding materials: cube-shaped steel frames, quarry stone, cast concrete blocks and old cement-weighted car tires. Sections of reefs consisting of these materials are being sunk about 180 meters apart to develop commercial and sport fishing in the experimental area. Alfred Butcher, director for the Australia Department of Fisheries and Wildlife, has begun "seeding" abalone on the quarry stone reefs to see if a commercial venture can be realized from developing artificial reefs as Japan has done.

Offshore oil rigs, long a source of disdain among environmentalists, have become natural housing developments for large numbers of fish, just as pier pilings serve the same unintended use in coastal harbors.

Although *hydrostructure* is in its infancy, the building of artificial reefs is based on sound theory: throughout the centuries shrewd fishermen have been casting their nets perilously close to shipwrecks and other underwater obstructions, knowing that is where they will find the best catch. Hopefully, this coinage of a new word may come to represent a modern day era of building under the sea today for the betterment of mankind tomorrow. We are beginning to realize that man's survival depends on careful husbandry of our ocean as well as terrestrial resources. The seas and oceans are our bailment, our heritage and our legacy; just as we are not islands unto ourselves, we cannot continue to reap from the sea that which we have not planted. □

Raising Manmade Marshlands

Barely visible crescent shaped outline shows location of former cove's shoreline.

The maintenance of inland and coastal waterways requires periodic dredging, yet the very act creates another requirement of equal importance: where to place the dredged material?

Improperly disposed of dredged material becomes an environmental pollutant; properly disposed of, the same material can become an ecologically valuable asset.

The following accounts relate successful experience by the Corps of Engineers to convert this dredged material into useful wetlands. First is a story from the Baltimore District describing the raising of new marshland on Maryland's Eastern Shore with the use of material dredged from a secondary tributary of Chesapeake Bay. The second story is reprinted with the permission of the *New York Times*. It explains how the New Orleans District formed a series of new marshlands along the Southwest Pass of Louisiana's Mississippi River Delta.

Slaughter Creek Solution

by Dick Whitaker
Chief, Public Affairs Office
Baltimore District

The original dredging of Slaughter Creek, on the Eastern Shore of Maryland, was completed in 1913, providing a 7-foot-deep by 100-foot-wide channel through a sand bar that extended from the mouth of the creek into the Little Choptank River off Chesapeake Bay. The channel has been used ever since by both commercial and recreational fishermen and the U.S. Coast Guard, a unit of which operates out of an installation on the creek.

By 1973, more than half a century after the original channel was dug, shoaling began to restrict navigation as well as the emergency operations conducted by the Coast Guard from its Slaughter Creek station. There was no question for Colonel Robert S. McGarry, Baltimore District Engineer, that maintenance dredging was required. There was a question, however, about where to deposit the dredged material, and a search was made for suitable upland disposal areas.

As required in a local cooperation agreement, the Dorchester County Commissioners offered several areas; but studies conducted by the Corps in conjunction with the National Marine Fisheries Services, the Fish and Wildlife Service, Environmental Protection Agency, and the Maryland Department of Natural Resources indicated that none of these was environmentally suitable.

Another possibility was open water disposal, but this was not accepted because of the marine life disruptions that could result.

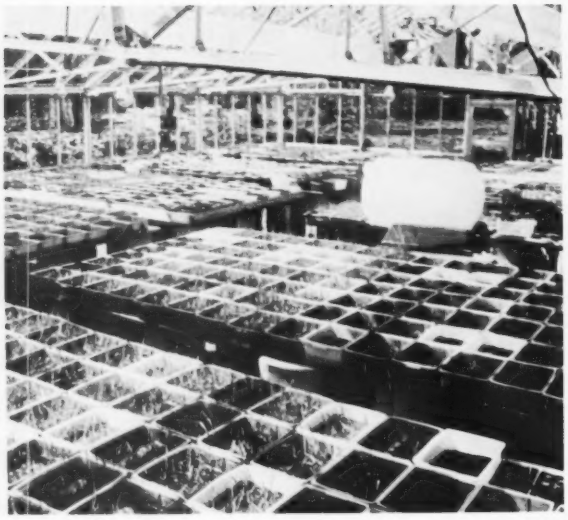
No viable solution was evident, and the Corps was ready to abandon efforts to accomplish the job despite the concern of the Coast Guard and area fishermen.

About that time, representatives of the Baltimore District conducting an on-site inspection considered the idea of creating a marshland out of dredged material and planting it in marsh grass. They found an area near the silted-in channel that had been subject to heavy erosion for years. The marsh land being proposed would not only provide a place for the dredged material taken from the creek bed but also act as a buffer against erosion and create more of a much needed commodity—wetlands.

This proposal was presented to the coordinating environmental agencies, a consultant with experience in this field, and an attorney representing the landowner affected. Everyone contacted agreed.

With renewed enthusiasm, a survey of the area was undertaken. The survey indicated that one of the sites in the eroded area formed a natural cove on the east bank of the creek mouth adjacent to naturally established wetlands. Furthermore, tests of the material to be dredged from the creek indicated it could support the growth of marsh grass.

Dredging of the channel was begun in the winter of 1973. The pilot project progressed another step in the spring of 1974 when a contract was awarded to



Greenhouse transplants of marsh grass were used to stabilize new wetland against future erosion.

Environmental Concern, Inc. of nearby St. Michaels for biological monitoring and vegetative stabilization of the dredged material.

The consultant firm, led by Dr. Edgar W. Garbisch, began growing several species of marsh plants in its greenhouses: cordgrass, saltmarsh hay, saltgrass, beach grass and big cordgrass. Both the dredging contractor and Dr. Garbisch were aware that the timing was critical for growing these plants under ideal greenhouse conditions and then transplanting them, because the dredging had to be completed early enough to allow the transplants to establish a root system that would sustain them through their first winter. Any delay in dredging would delay the planting; the plants would then become too large to transplant and would be lost.

Both the dredging and transplanting went smoothly, however, and soon there were about 3 acres of new wetlands covered by marsh grass in the cove. The following summer, about 19 percent of the new marsh was fertilized as part of a study that indicated the extent to which fertilization enhances vegetative production in sandy or other poor soils. After a full year of growth, what was once a cove eroding away at the rate of more than 2½ feet a year is now a lush wetland blending into the surrounding environment.

The eroding shoreline no longer exists in this part of Slaughter Creek and continuing studies show a large increase has taken place in biological production on the marsh. Baltimore District's dilemma has been solved by an idea that materialized into an environmentally useful project, an idea that is being seriously considered as a solution for other dredging projects. □

New marsh area, in red, replaces part of receding shoreline. Dotted line shows erosion of shoreline since 1842.

Engineers Build Marsh on Mississippi

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By Roy Reed
Special to the New York Times

NEW ORLEANS, Feb. 1—Emulating nature, the Corps of Engineers has built 352 acres of marsh complete with witch grass, smartweed and muskrats in the Mississippi River Delta south of here.

Man-made marsh is not new, but this is believed to be the largest one built in the United States. Both the corps and some environmentalists are hailing it as an encouraging step in the difficult struggle to preserve wetlands and marshes.

Donald G. Schueler, a member of the board of the New Orleans Audubon Society and one of this state's leading conservationists, was one of several environmentalists and observers who went by helicopter last week to see the project.

He said it had taken years of protests by environmentalists to get the corps to start such work.

Old Problem, New Approach

This marsh project and others around the nation represent a change in the corps' approach to one of its oldest problems: what to do with silt dredged from river and canal bottoms.

The corps in the past simply dumped the silt along the banks, a solution that conservationists found objectionable.

The corps is not studying the possibility of disposing of a large percentage of its dredged silt by turning it into marsh. The lower Mississippi marsh was built with sand and dirt dredged from the river channel to keep it open for navigation.

The corps experimented and found that the silt had to be built up two to three feet above sea level to become marsh. When it was piled higher it produced trees and shrubs instead of marsh grasses. At a lower elevation, nothing would grow.

The process is much like nature's spring flooding. "In effect," Charlton J. Nettles, the corps' chief of operations here, told the observers last Monday, "we're doing about the same thing a stream overflowing naturally would."

Marshland Disappearing

The corps is approaching marsh building with some urgency. Marshes and wetlands are threatened in many parts of the country. Spreading civilization is the problem in many places.

Southern Louisiana's coastal wetlands are disappearing at an estimated rate of 16.5 square miles a year. Some blame it on the canals and ditches built by oil companies that allow the Gulf of Mexico tides to encroach. Others point to the flood control levees built by the Corps of Engineers that prevent streams from building new delta land with their annual overflows.

The corps began a five-year study in 1973 to learn whether marsh-building was feasible. In addition to the Mississippi River project, the corps has built smaller, research-oriented marshes of 10 to 20 acres each on Branford Harbor, Conn.; the Columbia River and Grays Harbor in Washington; the coastal water of San Francisco; the Potomac and James Rivers in Virginia; the Intercoastal Waterway in Georgia, and Galveston Bay in Texas.

A number of other marshes have been built, most 100 acres or less, by private environmentalist groups and universities during the last five years, according to the corps.

The marsh on the Mississippi was begun last June. Seeds carried by wind, water and birds had vegetation growing by the end of the summer. The marsh is now sprigged with such plants as panic grass, witch grass, goose grass, dogtooth grass, water hyacinth, wild millet, a seaside heliotrope, dotted smartweed and elephant ear.

Wildlife Moving In

Herons, egrets, ducks and the nests of several muskrats were seen at the new marsh Monday. One fat nutria was flushed by the visitors. It scuttled across the sand flat to hide in the new grass.

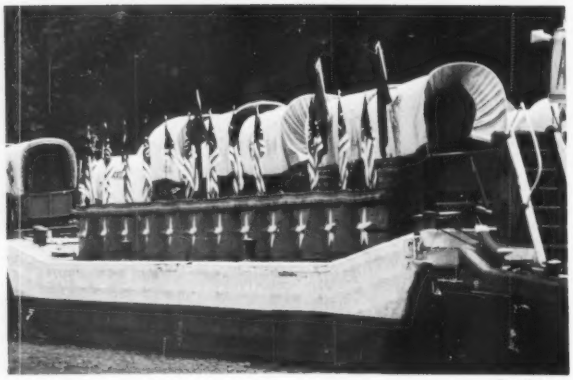
"Let's hope it's a pregnant female," an engineer said.

The corps does not represent its marsh-building, which is continuing, to be more than a fraction of the answer to Louisiana's wetland erosion.

"Admittedly, what we have accomplished is minor when viewed in the context of the over-all coastal problem," said Col. Early J. Rush 3d, the New Orleans district engineer. "However, we view it as a very important beginning." □

Two semicircular land masses in center are part of approximately 350 acres of new coastal marshland raised adjacent to Southwest Pass of lower Mississippi River from last year's dredging of 40-foot-deep navigation channel. New Orleans District hopes this year's maintenance dredging will double new wetlands created by open water disposal of dredged material and recover some of estimated 16 square miles of Louisiana coastal wetlands lost annually.

Events, Deeds & Deliberations



Earl Booth

The Santa Fe was one of several historic trails followed by the wagon trains on their way to Valley Forge.

Bicentennial Wagons Ride The Waterways

Five wagon trains of modern-day pioneers riding Conestogas and Prairie Schooners converged on Valley Forge for the Nation's Bicentennial—and some of them came by water.

Beginning in the summer of 1975, they set forth from every State under the sponsorship of the Bicentennial Commission of Pennsylvania.

The caravans from the far western states chose to travel the waterways for part of their journey. Wagons from the Northwest linked up into a wagon train in Wyoming and continued on to the Missouri River at Omaha, Nebraska. There they boarded barges provided by the American Waterways Operators, an association of barge owners which coordinated the 6-week, 1,600-mile waterborne segment of their trip. A second group of wagons from the Southwest transferred into waiting barges at Independence, Missouri.

The wagon laden barges rode down the Missouri River to its confluence with the Mississippi River and then turned northeast by going up the Ohio River as far as McKeesport, Pennsylvania where the wagons were disembarked.

On July 4th, they were among the 50 State wagons that rolled in review before local dignitaries on the site of the Continental Army's winter quarters of 1777 and 1778. Also passing in review were 160 independent wagons filled with Americans who had gathered from all over the land to join the great pilgrimage. □

General Marshall Becomes Deputy Chief of Engineers

Major General Robert C. Marshall became deputy chief of engineers in August, 1976. Among his past assignments he had been deputy chief of staff for logistics, U.S. Army Forces Command at Fort McPherson, Georgia and district engineer at Mobile, Alabama.

Brigadier General Richard M. Wells assumed command of the newly formed U.S. Army Middle East Engineer Division with headquarters in Saudi Arabia in July. General Wells formerly commanded the 4th Advanced Individual Training Brigade of the Engineer Training Center at Fort Leonard Wood, Missouri.

Colonel John H. Cousins was named director of the Army Coastal Engineering Research Center (CERC) at Fort Belvoir, Virginia in July. CERC conducts field and laboratory research on construction, protection and maintenance of coastal beaches and structures. Colonel Cousins formerly was deputy division engineer of the Ohio River Division at Cincinnati, Ohio.□

Water Is America's Future

A new exhibit sponsored and developed by the Corps of Engineers North Central Division was formally dedicated on June 29th in Chicago's famous Museum of Science and Industry.

The modular visitor-participation exhibit—titled "Water is America's Future"—blends factual appeal with the story of the Corps of Engineers, specifically in the Great Lakes, and its overall role in water resource management. Imaginative and attractive, the exhibit uses visual and audio techniques in 10 separate units.

One module gives a view of the Great Lakes as seen by a seagull. In another, a hand-cranked model of a lock allows the visitor to manually move a vessel through the stages of lockage. Other concepts developed range from the molecular structure of water, which explains why ice (solid water) floats, to a flowing water demonstration of the earth-shaping and destructive forces of water.□

"Water . . . Friend and Foe" exhibit demonstrates the force of water as it drips, freezes and flows.

Kentucky Rates Its Dams

The State of Kentucky classifies its dams by the amount of damage they could cause if they break.

Three categories have been established: low, intermediate and high hazard. Low hazard dams are those which could wash out with little resultant damage. They generally are located in agricultural areas. The intermediate hazard classification lists dams whose failure could damage isolated homes and major transportation arteries or could interrupt service of relatively important public utilities. A high hazard classification is required for dams whose failure would cause probable loss of life.

Under Kentucky law, the State Environmental Protection Department is responsible for inspecting dams at least every 5 years, depending on the potential hazards of the dams involved. Additional safeguards can be provided when the inspector determines that minimum standards are inadequate.□

Snails in Jeopardy

Fifteen types of American snail recently joined the more glamorous timber wolf and grizzly bear on the list of endangered species. The insignificant snail is of interest to us, according to a U.S. Office of Endangered Species biologist, because it actually is a valuable gauge used to measure the health of rivers and many other ecosystems.

The Virginia fringe mountain snail, strange many whorled land snail and painted snake coiled forest snail are among these species, jeopardized by siltation and pollution, which are also worthwhile in other ways. They are appreciated by birds and fish and serve as an important link in the food chain. Snails may hold a substance such as mercenine, found in clams, that could contain a cure for cancer.

Being listed as endangered species does not guarantee their survival, but it does provide them with legal protection from collectors and hunters. It also prohibits Federal agencies from authorizing, funding or carrying out projects, highways and dams, for example, that would harm them.□

Chesapeake Bay Model Enters New Phase

The largest estuarine hydraulic model in the world is completed and has entered into its period of adjustment and verification. Built by the Corps of Engineers on Kent Island at Matapeake, Maryland, the model will be ready to begin testing in the summer of 1977.

At that time it will be used to determine the impact on the Chesapeake Bay of either manmade or natural reductions in the amount of fresh water entering the Bay. In another of the initial tests to be performed, water supply and wastewater disposal in the Potomac estuary will be studied. A third test will determine the effects of deepening the Baltimore Harbor and channel to 50 feet.

The hydraulic model was built as part of a comprehensive Chesapeake Bay Study authorized in the River and Harbor Act of 1965. The study was initiated to thoroughly investigate the utilization and control of water in the Chesapeake Bay basin. During this investigation such areas as navigation, fisheries, flood control, control of weeds, water pollution, beach erosion and recreation have been examined.

After assessing existing conditions—physical, chemical, biological, economic and environmental—of the Bay, future water resource needs and problem areas will be projected to the year 2020.

The hydraulic model tests will establish the base upon which solutions to problems will be formulated and recommended. □

Rangers Show the Corps Cares

The concern for people and the environment expressed in the slogan, "The Corps Cares," was recently demonstrated by Corps of Engineers rangers at a reservoir in eastern Texas.

They conceived and sponsored an imaginative wildlife woodland contest for teenagers living in the Lake O'The Pines area. Four-member teams of Future Farms of America from local high schools entered the competition.

The contest covered a 1½-mile course. At designated stations along the way, the students were asked wildlife and forestry related questions about standing tree volume and value, ages of trees, identification of hardwood trees and selective thinning practices. They tried to choose the best wildlife food tree in the area and to determine whether the area was overstocked or understocked with wildlife.

Bronze plaques were awarded to the two winning individuals and teams. Certificates of merit were presented to the third place individual and team. □

In the continuing public interests versus private rights controversy, we still seem to be defining concepts. As one developer said to the Corps officer conducting a public meeting: "There ain't no environment there."

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